SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE, 1931.

GENERAL PHYSICS.

ision Chronograph. J. E. Sears, Jr., and 8. *pp.* 21–28, *Jan.*, 1931.—A me measurement of special investigations AUTHORS.

nponent Vibration , 1931.—The instru- ding displacements in three mutually ng powerful damping, with low friction, it is possible to record shocks met with in locomotives and rolling stock. It is possible to add two further pens, marking on the same chart as the three main ones, to indicate time, and to mark any desired instant, by making a contact. J. H. A.

ERRATA

Section A.—PHYSICS.

ract No. 422, lines 6 and 16; *for* Oswald, *read* Ostwald.

1738. Drop Method for Surface-Tension Measurements. J. Traube. *Kolloid Zeits.* 53. *pp.* 300–303, *Dec.*, 1930.—Comments upon the work of Junker [see Abstract 3 (1931)] and of Palitzsch [see Abstract 1271 (1930)]. The errors described by Junker may be avoided by greasing the outer wall of the drop-tube and by neglecting the first few drops; they do not arise if the author's special stalagmometer (constructed by Gerhardt's of Bonn) is employed. The stalagmometer is far superior to bubble-pressure apparatus and to surface-rupture apparatus (such as that of du Noüy), both as regards expense and ease of working; with non-colloidal solutions an accuracy of 1 to 2 % is obtainable, working at 15 to 30 drops/min. Greater accuracy is possible at slower rates of working, but these are frequently not justified if much ground has to be covered; hence a comparison with the drop-weight method is unfair, the two methods having their own distinct fields of application. L. V. C.

1739. Motion of Xylol Droplets on the Surface of Aqueous n-Propyl Alcohol. G. G. Kandilarow. *Kolloid Zeits.* 53. *pp.* 304–306, *Dec.*, 1930.—Xylol on pure water forms a thin film, but if drops of n-propyl alcohol are added the xylol film breaks up into lenticular droplets which, with suitable concentrations of alcohol, perform irregular motions analogous to those of camphor on water. The phenomena vary in type according to the concentration of the alcohol. The author classifies and interprets them on the basis that (1) xylol is practically insoluble in pure water, (2) n-propyl alcohol mixes freely with xylol and with water, (3) the surface tension of xylol is the same approximately as that of a 1 : 4 solution of the alcohol and therefore lies between the values for the pure alcohol and for pure water. L. V. C.

1740. Mechanical Applications of Surface Energy. V. Ducceschi. *Kolloid Zeits.* 54. *pp.* 13–17, *Jan.*, 1931.—The author has constructed light wheels of aluminium foil rotating about vertical axes, and provided with a number of inclined vanes. They dip partially into the surface of water contained in a rectangular trough. An aluminium plate is coated on one side with a thin layer of camphor, and placed vertically at 40 to 50 mm. distance from the wheel, so that the camphor faces the latter, the plate being partly immersed. The wheel begins to rotate and may continue to do so for 10 or 15 min., the wheel making some hundreds of revolutions before it stops. The rotation can also be brought about by painting the upper surface of the vanes with a solution of camphor in ether, before introducing the wheel into the water surface. The action is due to the same causes as the lively movements of small particles of camphor when they are allowed to fall on a water surface. In another apparatus an aluminium vane is balanced on a horizontal axis, and is provided with a vertical pointer capable of moving over a scale. The lower edge of the vane dips into water, and another vertical aluminium plate or a sheet of glass is placed on one side of it and dipped slowly into the water. The side towards the vane is previously coated with a thin layer of camphor. The vane is repelled from 3 to 6 mm., but the pointer returns to zero after a few seconds. In this way the force exerted upon the moving vane, by the thin surface layer of camphor molecules spread on the water surface, can be measured. H. N. A.

1741. Dependence of Viscosity of Cellulose Ester Solutions on Temperature. Parts II and III. E. Karrer, E. Berl and H. Umstätter. *Zeits. f. phys. Chem.* 152. *Abt. A.* 1–2. *pp.* 150–152, *and* 3–4. *pp.* 284–294, *Jan.*, 1931.—Further tests confirm the relation developed by Karrer and Nutting on thermodynamic grounds. Equally good agreement is obtained for the dependence of viscosity on temperature for cellulose nitrate or acetate and the viscosity values do not change appreciably after repeated heating and cooling, provided acid-forming substances or solutions are not used initially. The Berl-Büttler relation is found to hold with ample accuracy also for substances of viscous structure. By suitable choice of concentration and velocity gradient a laminar viscosity may be sought. [See Abstract 3615 (1930).] R. S. R.

1742. Problems of the Boundary State. W. Hardy. *Roy. Soc., Phil. Trans.* 230. *pp.* 1–37, *Jan.* 22, 1931.—A full summary and discussion of present knowledge of boundary lubrication, leading towards a theory of a fourth, or boundary, state of matter. Particular attention is devoted to explanations of the Leslie pressure and of the mean value rule. In liquids the boundary state is probably due to the existence of chains of highly polarised molecules extending throughout the lubricant, normally to the surfaces, from one boundary to the other. The intensity of polarisation is a function of the distances from these two surfaces, and is a minimum at a mean value surface. The tensile strength of such a chain is greater than its shear strength, but both magnitudes diminish as the chain lengthens. If the effect of an end group of atoms in the chain is allowed for, the relations between length and strength are linear; shear strength may be reduced to zero in a long chain. J. P. A.

1743. Anomalous Distribution of Velocity in Thin Lubricant Layers. H. Umstätter. *Kolloid Zeits.* 54. *pp.* 220–226, *Feb.*, 1931. —The derivation of the law of Hagen and Poiseuille governing the movement of a liquid in a capillary tube is checked and its limitations defined. A theory is propounded to account for the anomalous distribution of velocity in the liquid and is expressed mathematically to a first approximation. The following semi-empirical law connecting viscosity, molecular weight of the lubricant, temperature, and form of the molecules is expressed and is found to be supported by experimental data: $\eta = CM^2/(t - t')^n$, where η is the viscosity, C a constant which is characteristic for each homologous series and is symbatic with the dielectric constants, t the temperature, t' a reference-temperature determinable experimentally, and n an exponent which varies, according to the degree of electric symmetry of the molecule, between 1 and 2. T. H. P.

1744. Kinetic Theory of Liquids. R. O. Herzog. *Zeits. f. phys. Chem.* 10. *Abt. B.* 4–5. *pp.* 337–346, *Nov.*, 1930.—Jäger's equation, $\eta = P\rho/w$ (η = viscosity, P = intrinsic pressure, ρ = molecular radius and w = mean molecular velocity) applies accurately to mercury and to liquid hydrogen even when P is derived from van der Waals' " pressure constant " a for the corresponding vapour. For a number of organic liquids the agreement is not so marked, indicating that $w_{\text{liq.}}$ and w_{gas} are not identical for the latter, *i.e.*, that a different state of molecular aggregation exists in the two phases, whereas for Hg and liquid hydrogen the state of aggregation is the same. Riecke's equation, $D = \lambda w/3$ (D = diffusion coefficient and λ = mean free path), is applied to a number of solutions of organic liquids; D is the same for the *same* solvent with different solutes, hence a value is found for the diffusion coefficient of liquid molecules in their own liquid. For the liquids studied, $\lambda = 3{\cdot}5 \times 10^{-9}$ cm. approx., while $\rho = 2{\cdot}8 \times 10^{-8}$ cm. approx. Combining Jäger's equation with Riecke's, $\eta = P\rho\lambda/3D$, and combining the latter with one previously derived by the author [see Abstract 3913 (1930)], we have

$$\lambda = 2(V - b_{\text{liq.}})^{\frac{2}{3}}/3\cdot 7\pi N^{\frac{1}{3}}V^{\frac{1}{3}}$$

(b = van der Waals' " volume constant "). The author shows that the molecular displacement time (" *Platzwechselzeit* ") or " *Verweilzeit* " is related to Lindemann's " time of oscillation " of the molecules, and indicates its relation to Jäger's equation. L. V. C.

1745. Turbulent Flow through Tubes. W. N. Bond. *Phys. Soc., Proc.* 43. *pp.* 46–51; *Disc.*, 51–52, *Jan.*, 1931.—The flow of fluid through long straight tubes of circular section was experimented on, at speeds in the neighbourhood of the lower critical velocity, in an attempt to detect any trace of periodicity in the turbulent motion. The experimental methods included (*a*) an aural method, (*b*) photography of the motion of a deflected vane and (*c*) injection of colour-streamers about half-way along the tube. Intermittent turbulence was investigated at speeds near the critical speed, and measurements of the critical speed were made. It was shown that the velocity parallel to the tube-axis is sometimes almost uniform momentarily over the transverse section. No trace was found of a simple frequency, but evidence was obtained of a predominant wave-length in the turbulent motion at the critical speed. Both these observations seem to agree with the approximate theory for flow between a pair of parallel planes given by Heisenberg [see Abstract 2902 (1924)]. AUTHOR.

1746. Steady Rotation of an Anchor Ring in a Viscous Liquid. F. E. Relton. *Phil. Mag.* 11. *pp.* 129–139, *Jan.*, 1931.—Since the anchor ring rotates slowly about its axis, the path of each particle of the liquid is taken as a circle parallel to the equatorial plane, and in Part I the solution is found to depend upon Laplace's equation for a uniplanar vector, the analysis being developed partly in cylindrical and partly in ring co-ordinates. An expression for a multiple of the velocity is obtained as a cosine series in which the coefficients are Beta and Riemann P-functions. Two solutions are employed, valid in different regions; the one applies to an annulus with a viscous liquid core, the other to a liquid at rest at infinity. The validity of the result is limited by the ignoration of the inertia terms. In Part II the self-conjugate " rate of strain " dyadic is shown to consist of a single shear whose surface-value can be computed from the value of the velocity obtained in Part I. The surface value of this shear leads to an expression for the resisting couple. H. H. Ho.

1747. Damping of the Torsional Oscillations of a Sphere in a Viscous Medium. G. W. Brindley. *Leeds Philosoph. and Lit. Soc. Proc.* 2. *pp.* 159–162, *Jan.*, 1931.—With the object of modifying O. Meyer's disc method for measurement of the viscosity of a liquid, an expression has been developed for the logarithmic decrement of the torsional oscillations of a sphere in a viscous liquid. Experiments with water show that the observed damping is 5 to 10 % greater than the calculated value, but the cause of the discrepancy is obscure. It is not a result of the finite volume of the medium nor of convection currents arising from small differences of temperature. H. F. G.

1748. Viscous Flow and Surface Films. R. Bulkley. *Bureau of Standards, J. of Research,* 6. *pp.* 89–112, *Jan.*, 1931.—This paper describes experiments which have been made on the flow of various liquids through fine glass and platinum capillaries in an attempt to detect any departure from the laws of simple viscous flow. Such a departure could conceivably be brought about by an adsorbed layer on the walls of the capillary or by the attraction of the surface molecules of the walls upon the enclosed liquids. Flow-pressure graphs for various liquids in platinum and in glass capillaries have been obtained. The finest of these capillaries were, respectively, 9·35 and 5·59 μ inside radius. The results are in agreement with the laws of simple viscous flow for all of the liquids investigated. Calculations of the radii of the tubes show that the thickness of any immobile adsorbed layer on the walls was not in excess of two to three hundredths of a micron. The diameters of the smallest glass capillaries were measured microscopically and were found to agree satisfactorily with the calculated values. AUTHOR.

1749. Expansion of a Spherical Cavity in a Fluid. K. Kitagawa. *Kyoto Coll. Sci., Mem.* 14. *pp.* 23–42, *Jan.*, 1931. *In French.*—In this paper the hydrodynamic formula has been derived for the expansion of spherical cavities in masses of fluid either in the sea or in the atmosphere, and for the evaluation of the initial acceleration, the maximum speed, the depression of pressure which is produced to effect the expansion of the cavity considered, and the duration of the explosion. H. H. Ho.

1750. Eddy System in the Wake of Flat Circular Plates in Three-Dimensional Flow. Dorothy Marshall and T. E. Stanton. *Roy. Soc., Proc.* 130. *pp.* 295–301, *Jan.* 1, 1931.—The wooden water channel used was vertical, and the lower portion had a glass front and back. To introduce the colour into the stream two thin parallel discs were employed, very close together, and the colour was allowed to flow upwards through the vertical stem supporting the lower disc, through the centre of this, and out through the space between the two discs. Photographs of the eddy systems in the wake of circular discs of different diameters were taken. Between two limits, for low speeds of flow, a permanent vortex ring was developed below, or at the rear of the disc, with an external diameter greater than that of the disc, as described by Osborne Reynolds. When the flow exceeded the upper limit, successive portions of the vortex ring were discharged downstream at regular intervals of time. It was thought at first that the wake consisted of a spiral vortex, continuously unwound from the edge of the disc. It has been pointed out, however, by Rosenhead that there are strong theoretical reasons against such a conclusion, and that there is probably a periodic discharge from the disc of a series of rings of vorticity. This has been confirmed by taking a series of simultaneous photographs from directions at right angles to the direction of flow, and at right angles to one another. H. N. A.

1751. Nascent Cavitations in a Heavy Liquid. G. Bouligand. *Comptes Rendus*, 192. *pp.* 35–36, *Jan.* 5, 1931.—By the application of group theory the author shows that cavitations cannot appear in an incompressible fluid characterised by the existence, at a definite time, of a velocity field of zero divergence. J. S. G. T.

1752. Limiting Oseen Motion. J. Pérès. *Comptes Rendus*, 192. *pp.* 210–212, *Jan.* 26, 1931.—A limiting Oseen motion is a fluid motion derived from the integral equations of motion in which μ, the coefficient of viscosity, tends towards the limit, zero. The author shows that the Oseen differential equations of the limiting motion can be derived directly from the general differential equations of motion by proceeding to the limit $\mu \rightarrow 0$ directly, without integrating the equations. J. S. G. T.

1753. Types of Three-Dimensional Motion. Alayrac. *Comptes Rendus*, 192. *pp.* 213–215, *Jan.* 26, 1931.—The congruences discussed in a previous paper [see Abstract 333 (1931)] are shown to define certain physically possible types of fluid motion. J. S. G. T.

1754. Force between Two Cylindrical Vortices in an Incompressible Fluid. H. Arakawa. *Phys. Math. Soc. Japan, Proc.* 13. *pp.* 61–64, *Feb.*, 1931. *In English.*—The dynamics of two cylindrical vortices of circular cross-section in an incompressible fluid is discussed mathematically. The analysis indicates that if the intensities of the vorticities are equal in magnitude and opposite in sign then the vortices tend to approach one another along the line of centres. J. S. G. T.

1755. Aerodynamics of an Ellipsoid. L. Poggi. *Pont. Accad. Sci., N. Lincei, Atti*, 84. *pp.* 43–59, *Dec.* 21, 1930.—Considers the case of an ellipsoid of revolution subject to the action of (i) a vortex which is parallel to its axis and at a given distance below it, together with (ii) a straight line stream parallel to its axis. The theoretical results are worked out to give numerical data for certain assumed conditions. J. W. T. W.

1756. Behaviour of Surfaces Pierced with Lattice-Like Apertures in a Current of Air. New Aerodynamic Effect. E. Falkenthal. *Zeits. f. techn. Physik,* 12. 2. *pp.* 85–93, 1931.—Conditions for the production of turbulence in a stream of air incident upon and passing through a plane surface pierced with apertures arranged in lattice-like formation are discussed. The chief of these conditions are (1) that the apertures must have sharp edges and must be cut in a thin plate, and (2) that the width of the opening of the lattice unit must be about equal to the distance between the openings. Applications of such a device for the construction of wind screens, and apparatus for mixing gases and precipitating dust from gases are briefly discussed. J. S. G. T.

1757. Device for Concentrating Flowing Media. H. v. Hove. *Zeits. f. techn. Physik,* 12. 2. *pp.* 98–103, 1931.—A device is described comprising two adjacent Magnus cylinders, *i.e.*, two cylinders with flanges at either end, set up with their axes parallel to one another in a wind stream and caused to rotate. In the throat formed between the cylinders the velocity of the air stream is about three times the normal velocity of the stream. When the cylinders were not rotated the wind velocity in the throat was increased about 45 % above normal. J. S. G. T.

1758. Low-Vacuum Pressure Control. L. A. Richards. *Rev. Sci. Instruments,* 2. *pp.* 49–52, *Jan.,* 1931.—Apparatus for maintaining a supply of air at pressures less than atmospheric by certain definite amounts. The apparatus may also be used to maintain any constant vacuum (down to a few mm. of Hg) independent of atmospheric changes. There is a master-tank, in which a maximum vacuum is maintained by an air-pump; when the vacuum is impaired, the mercury in a manometer tube falls and breaks an electrical contact, thus liberating a relay which restarts the pump and restores the vacuum. Connected with this is a tank to be controlled; air flows from this to the main tank through a porous portion; this flow causes a column of mercury to shut off the flow from the porous section and thus to fix the pressure in the controlled tank. A. D.

1759. Vibrations of Elastic Network, and Water-Shock in a Network of Pipes. E. Volterra. *Accad. Lincei, Atti,* 12. *pp.* 420–425, *Nov.* 2, 1930.—Develops a theory for vibrations in an elastic network, and closely parallel to this a theory for water-shocks in a network of tubing. The results are expressed in a series of partial differential equations. A. D.

1760. Elasticity of Flexure. A. Jaquerod and H. Mügeli. *Helv. Phys. Acta,* 4. 1. *pp.* 3–30, 1931. *In French.*—As in a previous publication [see Abstract 876 (1930)], only data relating to the variation of the first modulus of elasticity with temperature are now published, and this for the following substances: iron, copper, gold, silver, platinum, silica, glass and nickel. The temperature range was 0° to 140° C., and the temperature-elasticity curves, which are given for each substance, are found to be similar to that of steel, *i.e.*, parabolic. Silica glass proved to be an exception, since it possessed a positive thermoelastic coefficient and almost a linear variation. Thermal and mechanical treatment generally produces an increase of Young's modulus: iron and silica glass exceptionally showing a diminution. Hooke's law is never completely obeyed even for small deformations. Nickel exhibits interesting phenomena. H. H. Ho.

V. 19

1761. Thermoelastic Effect in Cellulose Ester Films. J. G. McNally and S. E. Sheppard. *J. Phys. Chem.* 35. *pp.* 100–114, *Jan.*, 1931.—This paper contains an experimental study of the thermoelastic relations of cellulose nitrate and acetate films respectively, covering both the heat changes taking place when the films are stretched, and measurement of the coefficient of thermal expansion at different temperatures and stresses. Films that have not been subjected to large stresses on drying, cool when extended to small elongations, but become warm if the extension is prolonged beyond the yield point of the material. If the structure of the film is altered by drying the film under large stresses, the region of strain corresponding to the exothermic reaction disappears. Coagulated films containing large amounts of solvent showed the same thermal behaviour on stretching as the dry film, although the stress-strain relations were totally different. The existence of the anomalous Joule effect in a dry solvent-free cellulose ester film proves that the effect is not *a priori* evidence of a two-phase structure of the colloid, as has been suggested in the case of rubber. H. H. Ho.

1762. Bending of a Thin Elastic Circular Plate. N. M. Basu and H. M. S. Gupta. *Tohoku Math. J.* 33. *pp.* 280–291, *Jan.*, 1931.—This problem has been previously investigated on the basis of Kirchhoff's approximate theory for various kinds of distributions of load, but the interesting case in which the load is distributed uniformly along a radius has hitherto not received attention. The integral of the corresponding Green's function does not admit of easy evaluation, and the object of the present paper is to obtain an expression in the form of an infinite series readily amenable to numerical reckoning. For this purpose a more general problem has been considered at first, namely, the determination of the deflection produced when a part of the plate bounded by two radii and two concentric arcs is subjected to a load which, per unit area, is proportional to the reciprocal of the distance from the centre. The solution of the special problem above is then obtained by a limiting process, and although only the case of clamped edges is now considered, the method can easily be applied to work out the case of supported edges. H. H. Ho.

1763. States of Initial Stress and Strain. H. Reissner. *Zeits. f. angew. Math. u. Mechanik,* 11. *pp.* 1–8, *Feb.*, 1931.—General elastic theory is extended to cover cases where initial stresses exist throughout the volume, unbalanced by any external forces; the analysis being confined to cases where the body may still be considered elastically isotropic and homogeneous. The development shows that any state of initial stress may be considered to result from the superposition of a system of " permanent " initial strain, and a system of " elastic " strains. By introducing a set of body forces the " elastic " strains may be eliminated and an equation for the stresses in terms of the " permanent " strains found. It appears that " dislocations " of the Weingarten-Volterra type may be produced by initial " permanent " deformations, and that the displacements are then single-valued functions. If the initial stresses for each portion of the body are known, possible systems of " permanent " strains may be found by addition of particular solutions of the equations of compatibility. The problems of how far a given system of stresses is due to systems of dilatations or of shears, or of both; and of how a system of stresses is altered by lowering the limit of plasticity, are discussed. J. P. A.

1764. Initial Stresses in Elastic Structures. P. Nemenyi. *Zeits. f. angew. Math. u. Mechanik*, 11. *pp.* 59–70, *Feb.*, 1931.—A body subjected to no external forces may nevertheless be in a state of stress. A large part of modern research in the theory of elasticity deals with such bodies. This paper is a critical review of the whole subject and an endeavour to co-ordinate the various contributions. Starting with Volterra's "dislocations" considered as an extension of ordinary elastic theory, the author proceeds to the more general developments of Weingarten and Somigliana, all of which relate to indeterminate quantities in a plane or slice. When these quantities are regarded as distributed throughout a volume, we reach Reissner's work [see preceding Abstract]. Initial stresses associated with large deformations and with temperature differences are then considered, and the methods employed compared with those previously explained. Experimental methods and technical applications are alluded to, and a very full bibliography is included. J. P. A.

1765. Extension of Morera's Theorem. E. Gugino. *Accad. Lincei, Atti*, 12. *pp.* 401–403, *Nov.* 2, 1930.—Morera's Theorem (*Accad. Lincei Atti*, 2. 1893, pp. 243–246) is: Any two systems, ϵ_1 and ϵ_2, of forces acting on a system S of material points with bonds independent of the time determine, starting from rest, displacements generable in the same infinitesimal interval of time, these displacements being such that the work computed as by the forces ϵ_1 through the displacements corresponding to the forces ϵ_2 is equal to the work computed as by the forces ϵ_2 through the displacements corresponding to the forces ϵ_1. The author shows how to extend the theorem to the case where the bonds in the material system are reversible and may depend explicitly on the time. The resultant formula gives the same results as Morera's, except for a term of the third order, in time t. If the material system be solid and the displacements be infinitesimal and be generated in the same infinitesimal interval of time, the author's extended theorem leads direct to Betti's classical theorem of reciprocity, which is fundamental in the theory of elasticity. A. D.

1766. D'Alembert's Paradox and Kutta-Joukowski's Theorem. L. Poggi. *Accad. Lincei, Atti*, 12. *pp.* 404–409, *Nov.* 2, 1930.—Shows how the classical methods of investigating fluid plane motion within a cuspidate profile may be extended to d'Alembert's paradox and Kutta-Joukowski's theorem without any absurdity, these theorems retaining their validity. A. D.

1767. Mechanics of Continuous Systems. A. Signorini. *Accad. Lincei, Atti*, 12. *pp.* 411–416, *Nov.* 2, 1930.—Develops a new set of equations of Lagrangian type, useful for the service of particular problems in the mechanics of continuous systems. A. D.

1768. Mechanics of Rigid Bodies in Generalised Space. Angelina Cabras. *Accad. Lincei, Atti*, 12. *pp.* 416–419, *Nov.* 2, 1930.—Extends the study of the kinematics of generalised space to the statical and dynamical treatment of all the elliptical spaces. A. D.

1769. Rolling of a Heavy Solid on a Horizontal Plane. M. A. Omara. *Phil. Mag.*, 11. *pp.* 98–110, *Jan.*, 1931.—The motion of a heavy solid on a horizontal plane is discussed, and dynamical equations are derived, using Appell's "energy of acceleration" function. These equations are reduced to quadratures in the case of a solid of revolution. The nature of the path of the point of contact is investigated, and application to the special case of an ellipsoid of revolution is given. Author.

1770. Motion of a Particle on a Smooth Ellipsoid. Y. Hagihara. *Phys. Math. Soc. Japan, Proc.* 13. *pp.* 39–54, *Feb.*, 1931. *In English.*—The motion of a particle near the bottom of an n-dimensional ellipsoid under gravity is worked out to a second approximation. G. C. McV.

1771. Pressure between Two Bodies in Contact. J. P. Andrews. *Phys. Soc., Proc.* 43, *pp.* 1–7; *Disc.*, 25, *Jan.*, 1931.—When two solid bodies are pressed together without at any point exceeding the elastic limit, their common area of contact is frequently circular, and in such cases the normal stress at each point of this area may be calculated by a simple approximate method giving results correct, as a rule, to within 1 or 2 %. The approximation makes use of two principles: (*a*) The displacement at the centre of the circle of contact is twice that at its edge, and (*b*) for the purpose of calculating the stresses we may replace the two bodies by a single sphere of which the circle of contact is a diametral section, and write the strain at any point as the ratio of the displacement of that point to the length of the line drawn from the point to the sphere in the direction of displacement. When the elastic modulus with which this is multiplied is taken as that appropriate to a rod with sides fixed, the agreement with accurate theory is close. It is shown that the principle (*a*) remains nearly true for elliptical areas of contact. Author.

1772. Experiments on Impact. J. P. Andrews. *Phys. Soc., Proc.* 43. *pp.* 8–17; *Disc.*, 25, *Jan.*, 1931.—This paper, which describes the continuation of a research [see Abstract 3010 (1930)] upon the impact of soft metallic bodies, contains the results of four investigations, as follows: (1) Impact of equal spheres for low values of the velocity of approach v. The duration of contact is found to vary inversely as $v^{\frac{1}{5}}$, while the coefficients of restitution e in the same cases are found to be unity for all speeds below a value characteristic of each material, as though the metals were perfectly elastic for smaller speeds. (2) The effect of duration of contact upon the size of the permanent deformations. No effect was observed. (3) The variation of duration of contact t with mass of sphere at high speeds of approach. Within the limits of experimental error, t varies as the square root of the mass, as theory predicts. (4) The impact of crossed cylinders. No important new phenomena are found. Author.

1773. Observations on Percussion Figures. J. P. Andrews. *Phys. Soc., Proc.* 43. *pp.* 18–24; *Disc.*, 25, *Jan.*, 1931.—The formation of percussion figures by the pressure of a steel ball on glass blocks is here traced out, and an investigation suggested by this exploration elicits the following facts: (1) The diameter of the innermost circular or part-circular crack remains constant for one specimen of glass, and is independent of the maximum pressure exerted by the ball on the glass. (2) The diameter of the outermost circular or part-circular crack varies with the maximum pressure in a manner which suggests that the crack tends to keep to the outer edge of the area of contact. (3) No crack is formed until the pressure exceeds a value characteristic of the glass. A method of testing the fragility of glass is developed: and finally some observations on percussion figures upon spherical surfaces are mentioned. Author.

1774. Discrete and Continuous Theories in Physics. A. Ruark. *Phys. Rev.* 37. *pp.* 315–326, *Feb.* 1, 1931.—The differential character of the principal equations of physics implies that physical systems are governed by laws which operate with a precision beyond the limits of verification by experiment. This appears undesirable from an axiomatic standpoint. We may safely assume that all results obtained experimentally can be described by using real and finite functions of real, finite and rational variables. It appears desirable, therefore, to use the calculus of finite differences in formulating the results of our experiments. In dynamics the use of this calculus yields terms corresponding to the fact that the configuration is known only when we observe it and must be arbitrary at intermediate times. For example, if a "uniformly moving particle" is observed once a second, we find experimentally that $\Delta^2x/\Delta t^2 = 0$, whence $x = Ft + G$. Here F and G are *arbitrary* Fourier series having the period Δt. The general difference equations of dynamics are formulated. The Lorentz transformation is reinterpreted, relativistic difference equations of motion and of light propagation are set up, and geodesics in a discrete manifold are discussed. Extensions of these ideas to electrodynamics are outlined. AUTHOR.

1775. Principle of Maupertuis. F. D. Murnaghan. *Nat. Acad. Sci., Proc.* 17. *pp.* 128–132, *Feb.*, 1931.—The principle is generalised to the case of an arbitrary Lagrangian function in which one co-ordinate (not necessarily the time) does not appear explicitly. The explicit formulation of the integrand of Maupertuis is given for this case. G. C. McV.

1776. Theory of Damped Oscillations. V. S. Vrkljan. *Zeits. f. Physik*, 67. 3–4. *pp.* 289–291, *Jan.* 12, 1931.—In this entirely mathematical paper the law of the decrease of surface velocity is derived for damped elliptical oscillations. H. H. Ho.

1777. General Integration Process for Quasi-Harmonic Oscillations. E. Schwerin. *Zeits. f. techn. Physik*, 12. 2. *pp.* 104–111, 1931.—A process is derived for a quasi-harmonic oscillation based on the assumption that the elasticity and disturbing force curves are linear functions of the time, and is then applied for the investigation of large elasticity fluctuations. Numerical evaluations of some practical elasticity problems are included, together with a comparison of position and width in the instability region. H. H. Ho.

1778. Improvement of Foucault's Pendulum and the Maintenance of Oscillations. Charron. *Comptes Rendus*, 192. *pp.* 208–210, *Jan.* 26, 1931.—Difficulties encountered on a repetition of Foucault's pendulum experiment, due to asymmetry of the suspended body, the suspension and its point of attachment, are readily eliminated by mounting a small horizontal ring at a little distance below the point of suspension. Friction between the suspending wire and the ring causes the trajectory of the bob to be plane and not oval. Oscillations are maintained by an electromagnet energised by a current from an 8-volt dry battery which is closed by contact between the suspending wire and the ring. A few particulars of such a pendulum erected at Angers are given. See also *Remarks* by **de Sparre**, *ibid.*, pp. 320–321, Feb. 9, 1931. J. S. G. T.

1779. Free Pendulum. S. O. G. Hagen. *Pont. Accad. Sci., N. Lincei, Atti*, 83. *pp.* 59–61, *Dec.* 29, 1929.—A method of observing the oscillation of a free pendulum is described. An electric lamp is attached to the plummet, which moves above a photographic plate either fixed or attached to a chronometer apparatus. The curve thus traced enables all the characteristics of the freely swinging pendulum to be studied.

W. A. R.

1780. Crystal Structure of Veronal. E. Hertel. *Zeits. f. phys. Chem.* 11. *Abt. B.* 4. *pp.* 279–290, *Jan.*, 1931.—Veronal is found to be rhombic-bipyramidal, with four molecules to the unit cell. The translation group is Γ_0', and the space group V_h^{17}. Molecular symmetry C_{2v}. Models are suggested for the form of the veronal molecule and for the lattice.

F. I. G. R.

1781. Crystal Structure of Guanidonium Chloride. W. Theilacker. *Zeits. f. Krist.* 76. *pp.* 303–309, *Feb.*, 1931.—The constants are, $a = 7 \cdot 76$ Å.; $b = 9 \cdot 22$ Å.; $c = 13 \cdot 06$ Å. with $a : b : c = 0 \cdot 842 : 1 : 1 \cdot 416$; There are eight molecules CH_6N_3Cl to the unit cell. The symmetry is rhombic.

F. I. G. R.

1782. Crystal Structure of Kathode Deposits. (Miss) Z. Debinska. *Acad. Polonaise Sci. et Lettres, Bull.* 9–10. *A. pp.* 460–463, Nov.-Dec., 1930.—An experimental study of the influence of temperature of the kathode plate, during the period of pulverisation or deposition of the layer on its surface, upon the size and orientation of the microcrystals in the layer. The order of thickness of the layer is some few mμ. The practical details record the adaptation of a special type of discharge tube. It is found that the minute particles covering the electrode forming the surface layer obtained at temperatures from − 80° to − 180° C. have not a crystalline structure. A temperature of several hundreds of degrees, however, produces both crystalline structure and orientation of the crystals. A minimum temperature exists below which the phenomena are non-existent.

S. G. B.

1783. Growth and Dissolution of Non-Polar Crystals. I. N. Stranski. *Zeits. f. phys. Chem.* 11. *Abt. B.* 4. *pp.* 342–349, *Jan.*, 1931.—A discussion on the growth and dissolution of typically homopolar and metallic crystals, and on their catalytic and solidification phenomena.

T. H. P.

1784. X-Ray Investigation of Diphenyl and Its Optically-Active Derivatives. G. L. Clark and L. W. Pickett. *J. Phys. Chem.* 53. *pp.* 167–177, *Jan.*, 1931.—Rotating and oscillation methods have been applied to determine the structure of diphenyl and the following five derivatives: dimesityl; 3, 3′-diaminodimesityl; hexachlorodiphenyl; *o*-Tolidine; diphenic acid. Of these compounds, the first three are monoclinic and the rest are orthorhombic. Diphenyl has a centre of symmetry, the others possess no element of molecular symmetry. The numbers of molecules in the unit cell are (in order for the compounds mentioned), 2, 4, 4, 8, 4, 8. For earlier work [see Abstract 491 (1930)].

F. I. G. R.

1785. Influence of Impurities on the Physical and Crystallographical Properties of Hemimellitic acid. V. Agafonoff. *Comptes Rendus,* 192. *pp.* 99–101, *Jan.* 12, 1931.—The existence of polychroism in the ultra-violet is attributed to the presence of two substances α and β which remain in small amounts in the lattice of hemimellitic acid. The analytical details are:—

α Crystals.		β Crystals.	
Ca	0·44	C	41·58
Al	0·09	H	3·87
Mn	0·013	O	44·50
Organic matter	99·457	Residue from combustion	10·05
	100·000		100·00

The crystals α and β are monoclinic, whereas hemimellitic acid is triclinic with axial ratios $a : b : c = 1·705 : 1 : 0·6185$. F. I. G. R.

1786. Lattice Constant of Quartz. O. Bergqvist. *Zeits. f. Physik*, **66. 9–10.** ***pp.*** **494–498, 1930.**—The lattice constant of quartz has been determined to first and second approximations using the Cu $K\alpha_1$ and the Fe $K\alpha_1$ lines. F. J. W.

1787. Lattice Energy and the Combined State. W. Klemm. *Zeits. f. phys. Chem.* 12. *Abt. B.* 1–2. *pp.* 1–32, *Feb.*, 1931.—The coordination lattices of halides, oxides and sulphides in which the kation possesses the inert gas configuration may be characterised by the "energy quotient," which is the ratio of the lattice energy derived experimentally from the Born cycle to the energy which a coordination lattice of ions of the same size and charge would possess if the ions were of the inert gas configuration; the energy of such a "normal" lattice may be calculated from a simple empirical equation. An analogous function is the "molecular energy quotient," namely, the ratio of the energy of formation of gaseous molecules from the free ions to the theoretical value of the energy for corresponding compounds wherein the kations are of the inert gas configuration. Calculation of the two functions for various halides shows that members of the main groups of the periodic classification are more strongly differentiated from those of the sub-groups by their molecular energy than by their lattice energy. The transition from coordination to molecular lattice and from ionic to atomic lattice is discussed in terms of the respective energy quotients. In contradiction to the assumption of Rabinowitsch and Thilo [see Abstract 2097 (1930)], it is not possible to define a limit between these types of combination solely on the grounds of energy relationships. H. F. G.

1788. Lattice Energies from the Thermodynamic Aspect. J. H. Hildebrand. *Zeits. f. Physik*, **67. 1–2.** ***pp.*** **127–134,** ***Jan.*** **12, 1931.**—A number of limitations upon the validity of the usual (Born) energy equation for simple crystals are discussed. The thermodynamic equation $(\partial E/\partial v_T) = (\partial p/\partial T)_v - p$, where E is the total energy, only yields the value zero at the absolute zero of temperature, or for high pressures. The present author has already [see Abstract 903 (1930)] given a method whereby the uncertain extrapolation of the compressibility to the absolute zero can be avoided. Further, it is shown that $(\partial E/\partial v)_T$ can only be a pure volume function if the coefficient $\left(\frac{\partial C_v}{\partial v}\right)_T$ is itself independent of v. Estimates indicate (in the absence of direct experimental evidence) that this coefficient is in fact very small compared with $(\partial E/\partial v)_T$. Some amended values for the index n are obtained for six of the alkali halides; they are decidedly higher than those resulting from the usual Born-Landé treatment, which appears to attribute greater "softness" to the ions than they really possess. A calculation of the lattice energy of KI agrees well with the value determined otherwise by Mayer [see Abstract 3284 (1930).]

F. I. G. R.

1789. Transfer of Energy between Atoms in Collision. O. K. Rice. *Nat. Acad. Sci., Proc.* 17. *pp.* 34–39, *Jan.*, 1931.—Recently Kallmann and London [see Abstract 2361 (1929)] have considered the question of energy exchange between atoms or molecules, and have concluded that it is possible to account theoretically for the fact that energy exchanges sometimes take place over distances much greater than are comparable with atomic or molecular radii, the relative translational energy of the colliding atoms or molecules being neglected completely. On this account a modification of Born's method is outlined, which takes into account the mutual kinetic energy of the particles and meets the objections made by Kallmann and London to the original Born method of solving collision problems. The paper is entirely mathematical. H. H. Ho.

1790. Parachor and Chemical Constitution. Part XVI. Silicon Compounds. S. Sugden and H. Wilkins. *Chem. Soc., J. pp.* 126–128, *Jan.*, 1931.—Data are given for a number of silicon compounds which show the constant for silicon to be about 28 and which indicate that the data of Ramsay and Shields for silicon tetrachloride [*Chem. Soc., J.* p. 1089, 1893] probably contain serious error. H. H. Ho.

1791. Molecular Structure of Triatomic Gases. P. C. Mahanti. *Phys. Zeits.* 32. *pp.* 108–110, *Jan.* 15, 1931.—This paper deals with the dipole moments, the Raman spectra, and the infra-red absorption bands of the molecules of H_2O, H_2S and N_2O. The molecule of H_2S has probably a triangular shape, while that of NO_2 is symmetrically linear [see Abstract 906 (1930)]. E. E. F. d'A.

1792. Isotopic Constitution and Atomic Weights of Zinc, Tin, Chromium and Molybdenum. F. W. Aston. *Roy. Soc., Proc.* 130. *pp.* 302–310, *Jan.* 1, 1931.—Unsuccessful experiments were made with Cd and Ge. For Zn the compound zinc methyl was employed, using the method of intermittent exposures, and photometry of the mass spectrum. The following are the mass numbers of the isotopes, with the percentage abundance of each: 64, 48·0; 65, 2·5; 66, 25·9; 67, 5·3; 68, 17·1; 69, 0·85; 70, 0·38. The atomic weight of zinc is calculated as 65·38 ± 0·02, which is in exact agreement with the best chemical determinations. Sn was also investigated by means of its methyl compound; it has 11 isotopes, and their mass numbers are too close to permit of the use of the method of intermittent exposures. The method used for Xe and Hg was employed. The following are the mass numbers, followed in each case by the percentage abundance; 112, 1·07; 114, 0·74; 115, 0·44; 116, 14·19; 117, 9·81; 118, 21·48; 119, 11·02; 120, 27·04; 121, 2·96; 122, 5·03; 124, 6·19. The calculated atomic weight is 118·72 ± 0·03; chemical methods give 118·70. With Cr the volatile hexacarbonyl was used. Mass numbers and percentage abundance as follows: 50, 4·9; 52, 81·6; 53, 10·4; 54, 3·1. Atomic weight calculated 52·011 ± 0·006 virtually identical with chemical value. A carbonyl of Mo was employed, and certain difficulties were met with, so that great accuracy cannot be claimed. The mass numbers and percentage abundances are as follows:

92, 14·2; 94, 10·0; 95, 15·5; 96, 17·8; 97, 9·6; 98, 23·0; 100, 9·8. Atomic weight 95·97 ± 0·06, chemical value practically 96. Three new isotopes have been found with Cr, and the seven isotopes of Mo are all new. Packing fractions and isotopic moments are also given. H. N. A.

1793. Possibility of Separating Neon into its Isotopic Components by Rectification. W. H. Keesom and H. van Dijk. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 42–50, 1931. *Comm. No.* 213*a from the Phys. Lab., Leiden.*—Considers the theory of the difference between the vapour pressure of the two isotopes Ne^{20} and Ne^{22}, as solids, at the temperature of the triple point, 24·57° K., as first calculated by Stern, and first published by Lindemann. The authors have attempted to obtain a partial separation by rectification in a rectifying column just above the triple point. The first two attempts did not give absolutely certain results, but in the third a difference in density of 0·4 % was obtained. The experiments are being continued, but it appears certain already that the lighter of the two isotopes has the higher vapour pressure. This indicates, according to the theory, that it is probably necessary to reckon with zero point energy for the solid state. Without zero point energy the reverse would be the case. H. N. A.

1794. Persistence of Molecular Rotation and Vibration in Collision. O. Oldenberg. *Phys. Rev.* 37. *pp.* 194–201, *Jan.* 15, 1931.—The present paper attempts to explain some observations on the exchange of vibrational and rotational energy of molecules on the basis of the laws of impact, taking into account the postulate of quantisation. It is pointed out that when one of the bodies involved in the impact is much lighter than the other the exchange of energy becomes improbable. The persistence of rotation of HgH molecules in an excess of nitrogen, suggested by Beutler and Rabinowitsch [see Abstract 4142 (1930)], is discussed. A related phenomenon is found in some chemical activations produced by H_2 molecules but not by any other molecule. The resonance rule for the probability of impacts of the second kind needs some modification for the exchange of vibrational and rotational energy between molecules. The transfer of vibration and rotation from the excited iodine molecule is discussed. In electron impact, the rotation of the molecule does not change, but the vibration does. This is interpreted on the basis of a hypothesis introduced by Franck and Jordan. Within ordinary gases, N_2 or H_2 or I_2, no persistence of vibration or rotation should be expected. AUTHOR.

1795. Characteristics of Nuclear Electrons. J. Kudar. *Phys. Zeits.* 32. *pp.* 34–37, *Jan.* 1, 1931.—A discussion of recent theories of the structure of the atomic nucleus. J. J. S.

1796. Masses of the Electron, the Proton, and the Universe. A. S. Eddington. *Cambridge Phil. Soc., Proc.* 27. *pp.* 15–19, *Jan.*, 1931. —Mentions improvements of the author's theory of the constant $hc/2\pi e^2$. The numerical value 137 is retained. The theory now appears to give correct or approximate values for the masses of the electron, the helium atom and the cosmos, in terms of the mass of the proton. Taking the case of the helium atom it appears that, since the nucleus can be regarded as rigid, the number of ignored degrees of freedom is increased from 136 to 137, and the result will be that the masses of the protons will be decreased in the ratio 136/137, and the masses of the electrons increased in the ratio 137/136; the latter prediction cannot be checked, but the former is a very good approximation to the " packing fraction " for helium. By means of an argument based on the fact that the microscopic systems concerned, with 136 relativity rotations, are transplanted for practical observation into a space time with only ten cyclic degrees of freedom, the author deduces that the ratio of the mass of the proton to the mass of the electron is $(136/\sqrt{10}) \div (\sqrt{10}/136) = 1849 \cdot 6$. Calling the ratio of the electrostatic repulsion between two elementary charges to their gravitational attraction F, we have $F = e^2/Gm^2$. The author considers that m should be taken as the square root of the product of the masses of the proton and the electron, and so finds $F^2 = 5 \cdot 3 \times 10^{78}$. $F^2 = aN$, where N is the number of particles in the universe, and a is a geometrical factor not differing greatly from unity. H. N. A.

1797. Causality in Behaviour of Electrons. A. Sommerfeld. *Ann. d. Physik*, 7. 8. *pp*. 889–891, *Jan*. 5, 1931.—A reply to J. Stark [see Abstract 365 (1931)]. J. H. A.

1798. Motion of Free Electrons in Electromagnetic Fields. E. H. Kennard. *Nat. Acad. Sci., Proc.* 7. *pp*. 58–62, *Jan.*, 1931.—The problem is treated on quantum-mechanics principles by the Ehrenfest method. Formulae are obtained for the motion of the centroid of any wave-packet representing an electron, in a general electromagnetic field. The non-relativistic case alone is treated. The centroid of the wave-packet is found to move, in uniform fields, according to the classical theory, but in non-uniform fields its acceleration is a kind of average of the classical value. G. C. McV.

1799. Interpretation of Dirac's α Matrices. G. Breit. *Nat. Acad. Sci., Proc.* 17. *pp*. 70–73, *Jan.*, 1931.—It is known that in a certain sense the matrices a_1, a_2, a_3 used by Dirac in his relativistic equation have the significance of velocities. Schrödinger has recently shown how, from a certain point of view, the motion of a free electron may be decomposed into two parts: a uniform motion of translation and a superposed motion of a vibratory character. The author points out some of the characteristic features of this interpretation. He shows that (1) it is possible to have solutions of the general relativistic one-electron problem which correspond to one of the a_K having definitely a given value, say $+ 1$ or $(- 1)$ at one particular time and which imply that the velocity is $- c$ or $(+ c)$ in the direction x_K, (2) such solutions give a definite value of an a_K only at one time, (3) such solutions for a free electron involve in general a finite probability of states of negative energy, (4) in the special case of the momentum p_K becoming infinite the probability of states of negative energy may become zero. H. L. B.

1800. Invariant Formulation of Dirac's Dispersion Theory. W. Wessel. *Zeits. f. Physik*, 67. 1–2. *pp*. 54–66, *Jan*. 12, 1931.—Dirac has given a non-invariant treatment of the problem of the mutual action between the electromagnetic field and charged matter. It is characterised by the fact that it does not make the charged matter generate the field and then allow the field to react on the matter but rather combines the two in a conservative system from the outset by assigning to them an energy expression for their mutual action. This method is here developed for the one-electron problem in a form invariant with respect to the Lorentz transformation. H. L. B.

1801. Application of Classical Statistical Conceptions to Undulatory Mechanics. J. Ullmo. *Comptes Rendus*, 192. *pp*. 87–89, *Jan*. 12, 1931.—Given the Schrödinger equation for three degrees of freedom, $\Delta\psi - h^2 V\psi/8\pi^2 m_0 = 4\pi i m_0 1/h \partial\psi/\partial t$, where V is the potential of the external forces, the author has investigated how ψ defines the probability of presence and the amount of motion at the geometrical point xyz of electrons subjected to the field of potential v. The paper is entirely mathematical. H. H. Ho.

1802. Wave Mechanics of a Wave-Field. G. C. Moisil. *Comptes Rendus*, 192. *pp*. 149–151, *Jan*. 19, 1931.—The author establishes the existence, in the phase-space, of a wave phenomenon in the sense of geometrical optics, corresponding to a field in physical space, the condition of which is known to obey the law of wave-propagation. G. C. Mc. V.

1803. Contribution to the New Theory of Quanta. E. Császár. *J. de Physique et le Radium*, 2. *pp*. 29–41, *Feb*., 1931.—The function ψ which occurs in the fundamental equation of wave mechanics is such that the $\int_0^\tau \Delta\psi_n/\psi_n \, . \, dt$ is invariant for infinitely slow changes of the parameters of the motion. Δ is the Laplacian operator and τ the period. The theorem is applied in a number of cases. G. E. A.

1804. Electricity, Ether and Quanta. R. Ferrier and F. Prunier. *R.G.E*. 15. *pp*. 83–90, *Jan*. 17, 1931.—In a previous paper [see Abstract 745 (1931)] Prunier has deduced certain properties of the ether from the Maxwellian equations considered as the most general equations of the ether. Ferrier now points out difficulties which are inherent to a theory based upon analogy between the equations of hydrodynamics and electrodynamics, and considers that the dynamical theory of matter is rather to be considered as a deduction from the more general equations of what he terms " autonomous dynamics." The respective authors reply to criticism of their theories. J. S. G. T.

1805. Upper Limit of Energy Density. W. Anderson. *Phys. Zeits*. 32. *pp*. 147–148, *Feb*. 1, 1931.—The author points out that the difficulty of an infinite energy density produced when a material particle turns into radiation can be overcome by supposing that the velocity of radiation never actually reaches the " limiting velocity," c, of relativity theory. The density of the gravitational energy of a sphere of very large mass in which the maximum density of matter has been attained is also calculated and is shown to be about twice the mass-density. G. C. McV.

1806. Internal Corpuscular Dynamics and the Origin of Gravitation. A. Kastler. *J. de Physique et le Radium*, 2. *pp*. 61–64, *Feb*., 1931.—The principle of equivalence suggests that gravitational force is a special case of accelerative forces in general, and the author suggests that its origin is to be found in the internal dynamics of the proton and electron, which is exhibited, for example, in phenomena associated with electron spin and the internal vibration characterising de Broglie's wave theory. J. S. G. T.

1807. Axially-Symmetric Stationary Gravitational Field. E. S. Akeley. *Phil. Mag*. 11. *pp*. 322–330, *Feb*., 1931.—Einstein's equations for the problem of a body rotating about an axis of symmetry are treated for a somewhat more general case than that already dealt with by Levi-Civita and Weyl. A first approximation to the solution for the field outside the body is given. G. C. McV.

1808. Unified Field Theory. Part IV. T. Y. Thomas. *Nat. Acad. Sci., Proc.* 17. *pp.* 111–119, *Feb.*, 1931.—The characteristic lines of the characteristic surfaces arrived at in Part III [see Abstract 1476 (1931)] are studied. These are identical with the geodesics of zero length of the space of distant parallelism and serve to determine a new set of local coordinates, the metrical local coordinates, which differ from the previous set [see Part I] in that the geodesics of zero length instead of the paths are straight lines at the origin of the local coordinates. It is then shown that a characteristic surface, referred to a set of metrical local coordinates at a point, appears as a spherical wave surface, with centre at the point and moving with unit velocity. G. C. McV.

1809. Einstein's Theory of Distant Parallelism. Part II. R. Zaycoff. *Zeits. f. Physik*, 67. 1–2. *pp.* 135–137, *Jan.* 12, 1931.—In continuation of previous work [see Abstract 1111 (1931)] the author deduces from the equations of Einstein's theory of distant parallelism a result which apparently contradicts some of Einstein's more recent deductions. The author's attempts to resolve this difficulty have hitherto been unsuccessful. J. S. G. T.

1810. Einstein's World Geometry. L. Infeld. *Phys. Zeits.* 32. *pp.* 110–112, *Jan.* 15, 1931.—The equations of the autoparallel lines in Einstein's new unified field theory are determined and are interpreted classically as the equations of motion of a dynamical system. G. C. McV.

1811. Law of Continuity in the General Theory of Relativity. M. Mathisson. *Zeits. f. Physik*, 67. 3–4. *pp.* 270–277, *Jan.* 21, 1931.—An exact mathematical solution of the problem of a point material particle in an external field is derived. In the very simplest cases the law of continuity in an extended sense, *viz.*, the law of constancy of charge, of mass, and of velocity, is deduced, the two latter holding only in the case of an uncharged particle in an external field having no electromagnetic component. J. S. G. T.

1812. Rotating Fluid in Relativity Theory. E. S. Akeley. *Phil. Mag.* 11. *pp.* 330–344, *Feb.*, 1931.—The solution of Einstein's equations for a rotating incompressible fluid is determined to the second approximation as a power series in ω^2/ρ, where ω is the (constant) angular velocity and ρ is the density. The first approximation corresponds to the Newtonian theory. The case for the figure of equilibrium corresponding to the Maclaurin ellipsoid of Newtonian theory is treated in some detail. G. C. McV.

1813. Riemannian Manifolds and Non-Euclidean Space Forms. P. Koebe. *Preuss. Akad. Wiss. Berlin, Ber.* 29. *pp.* 505–541, 1930.—In continuation of previous work [see Abstract 425 (1929)], the author discusses both open and closed hyperbolic space-forms characterised by singularities. J. S. G. T.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

1814. Coefficient of Correlation in Meteorology. R. Bilancini. *Accad. Lincei, Atti,* 12. *pp.* 426–430, *Nov.* 2, 1930.—It is current practice, when it is desired to ascertain whether two sets of observations have any relation to one another, to find the coefficient of correlation by dividing the one set by the other. This is strictly applicable only to two series linearly related to one another. The present paper is devoted to a mathematical enquiry into the value of the coefficient of correlation when the observations to be compared are themselves summations of differing functions. It may readily happen that the coefficient of correlation is entirely meaningless. A. D.

1815. Theories of the Circulation of the Atmosphere. E. W. Barlow. *Roy. Meteorolog. Soc., Trans.* 57. *pp.* 3–12, *Jan.,* 1931.—In a preliminary survey the large oceanic anticyclonic areas are considered together with their associated wind systems. A historical survey is given of views regarding the general circulation of the atmosphere. Lack of observations prevents complete synoptic charts being obtained of surface conditions all over the globe, and this is still more the case for the upper levels of the atmosphere. The general circulation in the troposphere can thus at present be only incompletely known. Unequal solar heating of the ground and surface air layers is taken as the cause of this circulation. The balance of the circulation and the temperature gradient equator to poles is disturbed by local winds and ocean currents. No effective explanation exists at present for the large oceanic anticyclones and problems of the stratosphere are largely unsolved. Finally, periodicities are examined and considered to be due to fluctuations in the intensity of solar radiation. R. S. R.

1816. Theory of Atmospheric Turbulence. H. Ertel. *Zeits. f. angew. Math. u. Mechanik,* 11. *pp.* 20–26, *Feb.,* 1931.—Hesselberg and Björkdal thought a Maxwellian distribution of velocities held in turbulent currents, just as for molecular velocities in a gas whose centre of gravity has a regular translation. Wagner developed a theory of squalliness and a frequency distribution for wind velocity and direction with a Maxwellian distribution. In this paper the equations of motion for laminar flow at the ground are developed and it is shown that the total velocity vector cannot have a Maxwellian law of distribution since this would contradict the hydrodynamical equations of motion. A general law of distribution for the horizontal component similar to that of Markoff and v. Laue is assumed which permits the possibility of a statistical correlation of the turbulence components, and thence of the velocity components. [See Abstracts 2929 (1928) and 15 (1930).] R. S. R.

1817. Cases of Discontinuous Fields of Rotation. J. Letzmann. *Phys. Zeits.* 32. *pp.* 43–47, *Jan.* 1, 1931.—A cylindrical vessel filled with an incompressible fluid is mounted in such a way that uniform positive or negative acceleration can be given to it, and the phenomena which occur at the walls and ends of the cylinder are considered. It is shown that the accelerated fluid is confined to a zone which has on its boundary a cylindrical surface of discontinuity or a zone of sharp transition. Within

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this accelerated zone there is a transition from motion on a circle concentric with the cylinder to sharper intersecting paths, and finally to turbulent motion. The distribution and arrangement of these layers are discussed, and the correspondence of this form of motion with that in waterspouts and whirlwinds is mentioned. [See Abstract 2755 (1930).]
R. S. R.

1818. Deposition of Dust from Air Currents and the Theory of the Dust Filter. F. Albrecht. *Phys. Zeits.* 32. *pp.* 48–56, *Jan.* 1, 1931.—Deposition of dust from air currents is investigated theoretically for the case of a cylinder, while experimental tests were made for the deposition of hoar-frost and are briefly described. The relations found in these theoretical investigations are applied to the conditions with dust filters. The properties of different kinds of filters are described, and two of them, the thread filter and the corrugated sheet-iron filter, are investigated theoretically. In order first to obtain theoretical data, stream-line flow is assumed. Relations to be expected when turbulence occurs are finally briefly demonstrated.
R. S. R.

1819. Absorption and Dissociative or Ionising Effect of Monochromatic Radiation in an Atmosphere on a Rotating Earth. S. Chapman. *Phys. Soc., Proc.* 43. *pp.* 26–45, *Jan.*, 1931.—The absorption of monochromatic radiation from the sun in an atmosphere of which the density varies exponentially with height is considered; the energy of the radiation, or a definite fraction of it, is supposed to dissociate or ionise the air, and the dissociation products are supposed to recombine with one another only, and not to diffuse away from the element in which they were formed. The resulting distribution of density of the dissociation products is determined, a constant recombination coefficient being assumed, while account is taken of the variation in rate of dissociation due to the earth's rotation. The results are illustrated by numerous diagrams, showing the density of the dissociation-products as a function of height, time, latitude and season.
AUTHOR.

1820. Semi-Diurnal Lunar Tidal Motion of Lake Baikal and the Derivation of the Earth-Tides from the Water-Tides. S. F. Grace. *Roy. Astron. Soc., M.N. Geophys. Supplement,* 2. *pp.* 301–309, *Jan.*, 1931.—Observations made at Pestchannaja Bay on Lake Baikal were analysed by Sterneck and he found the phase in agreement with theory, but the theoretical amplitude was approximately twice the observed value, the difference being attributed to frictional effects. The author applies a method described earlier [see Abstract 3074 (1930)] and obtains an amplitude nearly double the observed value. These results indicate the existence of an earth-tide at Lake Baikal approximately in phase with local astronomical forces along the median line of the lake and its magnitude is in fair agreement with accepted theory. The discussion also verifies the theory that, in a deep lake of small horizontal extent, the tides follow almost exactly the " equilibrium law."
R. S. R.

1821. Influence of Friction on the Tidal Motion of the Gulf of Suez. S. F. Grace. *Roy. Astron. Soc., M.N. Geophys. Supplement,* 2. *pp.* 309–318, *Jan.*, 1931.—In a former paper [see Abstract 3074 (1930)] an earth-tide was assumed for the Gulf of Suez and the lack of agreement between theory and observation was attributed to the insufficiency of accurate observations. The velocity of the M_2 tidal current in the Gulf of Suez is found at points along its medial line, and this determination used to evaluate the effects of friction. The results are compared for friction proportional to (1) the mean velocity and (2) the square of the mean velocity. Good agreement is obtained in each case. The force of friction necessary is about $1 \cdot 8 \times 0 \cdot 002\, \rho V^2$, a larger value than that given by Taylor, but although not true for the open sea it would hold for the Gulf of Suez on account of the numerous shoals and small islands. The variation of phase along the medial line of the Gulf cannot be accounted for without friction. R. S. R.

1822. Earthquakes and Tides. S. W. Visser. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 142–147, 1931.—Observations of Krakatau earthquakes for August, 1930, from registrations at Batavia, indicated increased seismic activity with each ebb, the hydrostatic pressure of the water counteracting upward seismic movements. Extension of the investigations to earthquake frequency and times of tides at Saparoea (Amahei), Banda (Moluccas), Padang (Sumatra) and Tjilatjap (Java) does not support this view. The time of increasing earth crust movement in relation to times of tides depends upon whether there is a general upward or downward movement of the crust in progress which would be more operative during low or high tide respectively. R. S. R.

1823. English Channel Earthquakes. A. E. Mourant. *Roy. Astron. Soc., M.N. Geophys. Supplement,* 2. *pp.* 374–383, *Jan.,* 1931.—Studies of the seismograms of earthquakes occurring in lands bordering on the English Channel during the years 1925–27, other than those studied by H. Jeffreys [see Abstract 851 (1928)], confirm and amplify the results and conclusions of the latter. W. A. R.

1824. Damping in Bodily Seismic Waves. H. Jeffreys. *Roy. Astron. Soc. M.N. Geophys. Supplement,* 2. *pp.* 318–323, *Jan.,* 1931.—The author obtains a modification of the equation for transmission of distortional waves due to imperfections of elasticity, such as elastic afterworking or firmoviscosity. It is shown to give rise to a reduction in the abruptness of P and S waves for distant earthquakes compared with the effect for near ones. The waves PP, PPP, SS and so on, reflected at the outer surface of the earth are much less sharp than the corresponding P and S waves. The action of a heterogeneous solid in producing these effects is discussed, and this theory is shown to account for the dying away of waves with a period of the order of 1 to 2 sec. for epicentral distances between 400 and 1600 km. R. S. R.

1825. Microseisms. F. J. W. Whipple and A. W. Lee. *Roy. Astron. Soc., M.N. Geophys. Supplement,* 2. *pp.* 363–373, *Jan.,* 1931.—The paper deals with the microseism recorded by the north component Galitzin seismograph at Kew 1926–1929, and at Eskdalemuir, 1915–1925. There is no regular diurnal variation in the amplitudes, but there is a tendency for the period of the microseisms at midnight to be greater than at midday. At Graz there are well-marked diurnal variations in the north and east components, but the amplitudes and periods are greatest at midday. The annual variation in microseismic activity gives larger amplitudes and longer periods in winter. W. A. R.

1826. Determination of Relative Values of Gravity at Potsdam, Greenwich, Ottawa and Washington. A. H. Miller. *Dominion Obs. Ottawa, Publ.* 11. 2. *pp.* 61–75, 1931.

1827. Gravity Distribution. A. Belluigi. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 1. 3. *pp.* 227–240, 1931. *In Italian.*—Analytical and graphical investigations of the distribution of gravity in a deep-lying, asymmetrical anticline are discussed. The errors that may occur in considering relief and gravity and which are due to confusing the effects of variations in the surroundings with anomalous concentration (*e.g.*, mineral deposits) are investigated. W. A. R.

1828. Thermal Effects of Blanketing by Sediments. H. Jeffreys. *Roy. Astron. Soc., M.N. Geophys. Supplement,* 2. *pp.* 323–329, *Jan.*, 1931. —The thermal effect of adding to the crust of the earth in its normal thermal state a thick deposit of sediments is considered. Conduction of heat into the sediments raises the temperature at the base and in time approximately the normal temperature gradient will be established through them. The heating effects considered are those due to (1) radioactive generation of heat after the sediments are laid down, (2) heat already present, and (3) pressure. It is shown that at a depth of 10 km. the rise of temperature accumulatin gfor 13×10^7 years can be 130° C. or so. This causes local weakening of the crust and horizontal stress, and consequently the region of prolonged deposition will be one of mountain formation. An explanation is also provided of Morley Davies' dilemma regarding the deposit of sediments in a given original depth of water. R. S. R.

1829. Isostasy and the Figure of the Earth. W. Heiskanen. *Am. J. Sci.* 21. *pp.* 39–50, *Jan.*, 1931.—Hopfner's conclusions [see Abstract 3068 (1930)] that the existence of isostatic compensation is questionable, that observed gravity anomalies can be fully explained by the warping of the geoid (Brun's term), and that the elevation and depression of the geoid referred to the spheroid are much greater than hitherto supposed, are discussed, and it is shown by consideration of actual gravity anomalies and observed deviations of the vertical, with deductions therefrom on isostatic principles, as compared with deductions from his theories, that his arguments, though founded on qualitatively correct bases, are quantitatively greatly in error. [See Abstract 1363 (1930).] C. A. S.

1830. Electrical Prospecting. A. Belluigi. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 1. 3. *pp.* 241–254, 1931. *In Italian.*—In calculating the depths of mineral deposits from the results of electrical field observations the chief difficulty is the determination of the lateral dimensions of the deposit. Approximate solutions can be obtained. Use is made of the relation between the potential and electromagnetic fields, especially fields with a non-elliptical structure. The Biot-Savart formula can be used to calculate the depth of the deposit. W. A. R.

1831. Geoelectrical Prospecting by A.C. Bridge Methods. A. B. B. Edge. *Nature,* 127. *pp.* 37–39, *Jan.* 3, 1931.—To determine surface potential, contacts are made by steel rods driven into the ground at three points (A, B, C), in a straight line, say, 50 ft. apart. All three are connected to a point O; AO and BO are ratio arms each including a condenser and resistance; in BO are headphones. Alternating current, usually of 500 ∼, is passed through the earth between distant electrodes. The potential drops between A and B, and between B and C are measured, and the process repeated at points B, C and D, D being 50 ft. farther on in the same straight line. In this way a potential anomaly curve is obtained. To compare electromagnetic fields (*e.g.*, the vertical) in the neighbourhood of conducting bodies: Two identical coils, each several square feet in area, are supported horizontally at two points a suitable distance apart, and connected so that the induced e.m.f.s assist one another. The ratiometer is inserted and operated *mutatis mutandis* as in potential determinations. C. A. S.

1832. Potential Due to a Buried Sphere. J. H. Webb. *Phys. Rev.* 37. *pp.* 292–302, *Feb.* 1, 1931.—A series solution of the problem dealing with the electrical potential due to a buried conducting sphere is given. The general method of attack consists in finding a solution of Laplace's equation $\nabla^2\Phi = 0$, subject to proper boundary conditions. The condition requiring the vanishing of the normal derivative of potential on the surface of the half space is satisfied by placing an image sphere in an upper half space. The introduction of this image sphere also introduces the complication of the interaction of the potential due to two spheres. This is handled by means of spherical harmonics and the solution of the problem is made possible by means of a special transformation in spherical harmonics. AUTHOR.

1833. Quantitative Determination of the Smallest Amounts of Helium. F. Paneth and W. D. Urry. *Zeits. f. phys. Chem.* 152. *Abt. A.* 1–2. *pp.* 110–126, *Jan.*, 1931.—The method employed depends on the principle of the Töpler pump for transport of the gas and of the improved Pirani-Stern hot-wire manometer. Full details are given of the apparatus and its experimental use. Volumes of He between 10^{-4} and 10^{-8} cm.^{3} can be measured. The sources of error are discussed while the accuracy attainable with the method is tabulated. For $0{\cdot}5 \times 10^{-6}$ cm.^{3} He the maximum error is 2 % and for $0{\cdot}05 \times 10^{-6}$ cm.^{3} He it is 10 %. [See Abstract 74 (1929) and following Abstract.] R. S. R.

1834. Helium Content in Iron and the Additional Components of Iron Meteorites and Terrestrial Metals. F. Paneth and W. D. Urry. *Zeits. f. phys. Chem.* 152. *Abt. A.* 1–2. *pp.* 127–149, *Jan.*, 1931.—An apparatus is described which with the exclusion of air and radioactive contamination permits determination of the He and Ra content of substances. For 37 iron meteorites the He content varied from $0{\cdot}23 \times 10^{-6}$ to 36×10^{-6} cm.^{3} He per gram of metal. In four cases troilite had a similar content and in one case schreibersite. For pallasite and mesosiderite the He content in the stone may much exceed that in the iron and also be irregularly distributed in the stone. For terrestrial samples no He content was found in two cases for Cu, but enough to indicate the geological age in two cases for Fe. Heating iron meteorites to 1000° C. for many hours caused only a few % of He to escape, this coming solely from the outer surface. This fact and also the inability of He to diffuse through glowing Pd show that the objection to the reliability of age determination by He methods depending on diffusion does not hold for iron meteorites. [See also preceding Abstract.] R. S. R.

1835. Revised Values of OI Terms; Nebular and Coronal Lines of Oxygen. J. J. Hopfield. *Phys. Rev.* 37. *pp.* 160–166, *Jan.* 15, 1931. —The chief triplet of oxygen λ1302 has been measured in the third order of a vacuum grating spectrum having a dispersion of 1·7 Å. per mm. On the basis of these measurements the ground triplet term of oxygen

$2s^2 2p^4\ {}^3P_2, {}^3P_1, {}^3P_0$ has the revised values 109837·1, 109679·17, 109610·52 giving the ionisation potential of oxygen as 13·550 volts. Nebulium lines have been produced in the laboratory for the first time. The two lines λ6300 and λ6364 have been remeasured, and their values, together with the new values of the $^3P_{012}$ term, are used to give more accurate values of the metastable levels of oxygen. The coronal line λ6374·2 is pointed out as being identical within limits of experimental error with the oxygen line λ6374·29. This would indicate the presence of oxygen in the solar corona. AUTHOR.

1836. Shift Towards Red of Calcium, Aluminium and Iron Lines in Solar Spectrum. J. Evershed. *Roy. Astron. Soc., M.N.* 91. *pp.* 260–270, *Jan.*, 1931.—The author investigates the shift towards red of the Ca lines H and K in the prominences which give a value greatly in excess of the relativity shift; from 380 prominence spectra, the mean shift gives + 0·015 Å. or 0·007 in excess of the Einstein shift. He compares this result with the shift of the same lines in the higher chromosphere. The levels are important, and there are four in question: (1) the narrow central cores H_3 and K_3 of the strongest Ca lines; (2) the next strongest Al (and NaD) lines; (3) the 11 strong Fe lines; and (4) the weaker Fe lines. He explains why weak and strong lines of the same element should represent different regions in the sun; he finds that the four distinct levels show shifts which are consistent with the relativity effect modified by Doppler effects as advocated by St. John. It is at level about 520 km. above the photosphere that lines of mean intensity 6 representing this level give exactly the Einstein shift; above 1000 km. the strong lines give an excess over relativity of about 0·35 km./sec. descent and H_3,K_3 of 0·94 km./sec. descent. The mysterious excess of shift at the limb amounting to a little over 0·5 km./sec cannot be explained by Compton scattering, and, if a Doppler effect, must be one which causes a recession at all points of the limb at all times away from the earth (an " objectionable Earth effect "). He gives a diagram of the variation between centre and limb for three groups of lines representing levels in the reversing layer. Assuming that the residual shifts are Doppler effects, it is the highest layers which come under the earth-repulsion and so also with the high-level chromosphere and prominences. A. S. D. M.

1837. Origin of the Axial Rotation of the Sun. R. Gunn. *Phys. Rev.* 37. *pp.* 283–286, *Feb.* 1, 1931.—In earlier papers the solar atmosphere has been shown to rotate rapidly as a result of the electric and magnetic forces which act on the atmospheric ions. At the equator the ionised layers move much faster than the solar surface proper, but this relative movement decreases with latitude in the manner required by observation. The fast-moving atmospheric layers transfer momentum to the sun proper, and its rotation is a necessary consequence of the observed atmospheric motions. The resultant torque is calculated and the angular acceleration shown to be adequate to account for the observed rotation. AUTHOR.

1838. Problem of *n* Bodies and the Expansion of the Universe. G. C. McVittie. *Roy. Astron. Soc., M.N.* 91. *pp.* 274–283, *Jan.*, 1931.—The author shows that the initial expansion required to establish the expansion of a universe of Lemaître type could be initiated by the formation of a number of condensations in an Einstein universe. [See also Abstract 1133 (1931).] J. S. G. T.

1839. Positions, Orbit and Mass of Pluto. S. B. Nicholson and N. U. Mayall. *Mount Wilson Observat. Contrib. No.* 417. *Astrophys. J.* 173. *pp.* 1–12, *Jan.*, 1931.—Positions of Pluto were obtained from photographs taken by M. L. Humason in 1919 with the 10-inch Cooke triplet and from photographs taken with the 60- and 100-inch reflectors in 1930. Orbital elements were computed which include the perturbations of the four major planets. The resulting period is 247·6968 years, which corresponds to a mean distance of 39·45743 astronomical units. The time of perihelion passage is 1989 Nov. 6·98 U.T., and the eccentricity 0·24852. The perturbations of Pluto on Neptune were used to determine the mass. A least-squares solution of twenty-two observational equations with the mass of Pluto and the corrections to four of the elements of Newcomb's orbit of Neptune as unknowns gave 0·94 ± 0·25 times the mass of the earth as the mass of Pluto. AUTHORS.

1840. Origin and Formation of Pluto according to Dualistic Cosmogony. E. Belot. *Comptes Rendus,* 192. *pp.* 147–148, *Jan.* 19, 1931.—Assuming that Pluto originated from a tube-vortex emitted by the giant proto-sun's equator, the author works out the numerical data as given by the theory of a dualistic cosmogony. A. S. D. M.

1841. Esclangon's Method for the Determination of the Orbits of Planets or Comets. N. Stoyko. *Bull. Astronomique,* 6. 6. *pp.* 263–274, 1930.—Reference is made to Esclangon's parallactic method to determine the orbit in which no assumption is made regarding the distance between the earth and the star and the arc described by the earth in the interval of observations. The author derives formulæ which are exact for the derivatives of the 4th order and can serve for calculation of the orbits of small planets and comets. Before solving the equations the results of observation must be introduced, this involving a change from heliocentric to geocentric or topocentric coordinates. In a second approximation allowance is made for the time of aberration. Knowing the rectilinear heliocentric coordinates of the star and their first derivatives for the initial date one can then calculate the elements of the orbit of the star in question and equations are given for these. For small planets or comets in the vicinity of large planets the influence of perturbations of large planets on the star is not negligible during the period considered, and for this Esclangon's method can be used. Finally, a method is given by which, after calculating the orbit from three observations, improvements can be made from later observations. [See Abstract 3678 (1930).] R. S. R.

1842. Planetary Nebulæ. Part I. H. Zanstra. *Zeits. f. Astrophysik,* 2. 1. *pp.* 1–29, *Jan.* 15, 1931.—A discussion of the mechanism of light-emission of a planetary nebula and a determination of the temperature of the central star, based on new measurements of the intensity of the spectrum of the nebula. The emission process of the light from the nebula is divided into two parts (1) ionisation of the nebula (assumed to consist of hydrogen) by the ultra-violet light from the star and recombination, (2) excitation of the "nebular" lines by electron collisions of the photoelectrons set free by the previous process. The temperatures of the central stars of N.G.C. 6572 and 6543 calculated on this theory are about 40,000° C. The emission process (2) is then used to calculate the temperature by a consideration of the difference between the luminosities of the star and the nebula. The temperatures of the central stars for a number of nebulæ are given and these range from 140,000° C. to 34,000° C. The temperatures for the two nebulæ already mentioned agree with the value given above. G. C. McV.

1843. Homographic Formulæ of Verticity and their Direct Development. J. P. Lagrula. *Comptes Rendus,* 191. *pp.* 1433–1435, *Dec.* 29, 1930.—A simple and direct method is given of deriving formulæ for verticity, based on an idea used by Turner since 1893. H. L. B.

1844. Diurnal Variations of Refraction. T. Banachiewicz. *Comptes Rendus,* 192. *pp.* 219–221, *Jan.* 26, 1931.—The new edition of *Tabulae Refractionum* of Pulkova contains a table of variations of the coefficient of refraction, which is based on the work of Harzer concerning the annual and diurnal variations in the constitution of the atmosphere. This table does not agree well with the Laplace-Oriani theory. A new and independent investigation has therefore been made, with the result that the theory is confirmed, and the regular daily variations in refraction are not to be attributed to changes in the atmosphere but to some other cause. M. A. E.

1845. Distribution of Double Stars in Space. S. C. G. Stein. *Pont. Accad. Sci. N. Lincei, Atti,* 84. *pp.* 33–39, *Dec.* 21, 1930.—In 1910 Aitken called attention to the fact that from observations of double stars made at Lick Observatory, it appeared that the number of close pairs was much greater than that of distant pairs, and although this could be partly explained by the method of selection, it seemed possible that they really are more numerous, even when parallax is taken into consideration. The question is dealt with mathematically in this paper, and it is shown that probably there is a real predominance of close pairs. Also, assuming that the distribution of binaries in space is the same as in our neighbourhood, much the greatest number of those with $\rho = 1''$ and $m = 14$ have periods of thousands of years. M. A. E.

1846. K Term of Stellar Radial Velocities. H. Mineur. *Comptes Rendus,* 191. *pp.* 1287–1289, *Dec.* 22, 1930.—When the mean radial velocity of stars is developed in a series of spherical functions the development contains a constant, the K term, which can neither be explained by the motion of the sun nor by the rotation of the stars as a whole. For very distant stars, spherical clusters and spiral nebulæ this term is proportional to the distance, and is explained by means of the hypothesis of de Sitter's closed universe. The author finds that for the B stars the K term is independent of the latitude, but that when the apparent magnitude increases K decreases at first, has a minimum value about magnitude 7·5, and then increases. It is suggested that the bright B stars belong to the local system, and tend to disperse in space. Values obtained by Shapley indicate that the local system of B stars is dispersing with a velocity of more than 5 km./sec. For the B stars outside the local system the K term is an effect of the curvature of the universe. For the other spectral types the term K is nearly zero, and seems to diminish as the distance from the sun increases. There is evidence that the stellar system has a tendency to flatten itself along the line joining the galactic poles. H. N. A.

1847. H.D. 185936. P. Guthnick. *Preuss. Akad. Wiss. Berlin, Ber.* 29. *pp.* 497–504, 1930.—The variable radial velocity of this star was

discovered by Plaskett in 1924–1925, and a series of photographs taken by Millman in 1927 indicated totally irregular changes in velocity and an occasional doubling of the lines. The star is of about 6th magnitude, belongs to type B3, and has very broad faint lines. When it was first placed on the list for photoelectric observation at Babelsberg in November, 1929, it seemed to have a very short and fairly regular period of light-change, but later on both its light and velocity changes became quite irregular, although it shows a certain likeness to 12 Lacertae. The phenomena certainly cannot be explained by supposing it a simple binary, and the doubling of the lines seems not to be due to the presence of a companion, but to emission lines appearing in the very broad absorption lines of hydrogen. These, even with the small dispersion used, are often seen to be very complex, and to vary in sharpness and in breadth. It is hoped to use higher dispersion this summer. It is clear that the sudden and rapid changes in brightness and in radial velocity are connected together.
M. A. E.

1848. Comparison of Revised Harvard Photometric and International Photovisual Systems between the Sixth and the Tenth Magnitudes. R. S. Zug. *Astrophys. J.* 73. *pp.* 26–39, *Jan.*, 1931.—The photovisual magnitudes of 297 stars have been determined with a probable error, ± 0·04 mag., on the International photovisual system, from photographs made at the Yerkes Observatory with the F. E. Ross 3-inch photovisual camera. A comparison of the adopted photovisual with the corresponding photometric magnitudes from the revised photometry, *Harvard Annals*, 54, 1908, yields the colour-equation and scale-difference of the revised Harvard photometry (4-in. photometer only) with respect to the International photovisual system. The colour-equation $Pv - Ptm$ was found for the spectral types Bo, Ao, Fo, Go, Ko and Mo to be + 0·02, 0·00, − 0·04, − 0·09, − 0·19 and − 0·32 mag., respectively. The scale-differences $Pv - Ptm$ at the Harvard photometric magnitudes, 6·5, 7·5, 8·5 and 9·5, were found to be 0·00, + 0·12 + 0·22, and + 0·30 mag. AUTHOR.

1849. Distribution of Absolute Magnitudes among K Stars Brighter than the Sixth Apparent Magnitude as Determined from Parallactic and Peculiar Velocities. G. Strömberg. *Mt. Wilson Observat. Contrib. No.* 418. *Astrophys. J.* 73. *pp.* 40–53, *Jan.*, 1931.—The distribution of absolute magnitudes among stars of spectral types K0–K2 and K3–K9 and brighter than apparent magnitude 6·0 has been determined from the distributions of parallactic and peculiar reduced proper motions and of radial velocities by methods previously described [see Abstract 411 (1931)]. The number of proper-motion stars in the two groups is 1058 and 375 respectively; of radial-velocity stars, 849 and 348. The distribution of absolute magnitudes for spectral types K0–K2 shows four distinct maxima: bright giants at − 2·5, normal giants at + 0·3, faint giants at + 2·7, and dwarfs at + 6·1. The relative proportion of stars in the four groups is 13·9, 78·3, 6·5 and 1·3 %. For the interval K3–K9 the distribution shows three distinct maxima: supergiants at − 4·5, normal giants at − 0·1 and dwarfs at + 6·7, the relative proportions of stars being 7·1, 90·5 and 2·4 % respectively. The distributions of reduced angular parallactic and peculiar motions and of the corresponding linear motions are given. Values are also given for the computation of the mean absolute magnitude for a group of stars from

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the mean apparent magnitude and the mean of the logarithms of the τ- or υ-components. AUTHOR.

1850. Relation between the Diameter of a Star and its Period of Axial Rotation. E. A. Kreiken. *K. Akad. Amsterdam, Proc.* 23. 9. *pp.* 1028–1042, 1930.—Surveys the results obtained on the relation between periods of axial rotation and the diameters of stars, only a general outline of the method used being given. The stars considered are the spectroscopic binaries, the Cepheid variables, the long period variables, the β-Canis-Majoris stars and the Pseudo Cepheids. The logarithms of the periods of the different groups of variables and spectroscopic doubles when plotted against the logarithms of the diameters indicate clearly the relation between the δ-Cephei and the β-Canis-Majoris stars, but no new light is thrown on the relation of the Cepheids and the long period variables. It also appears that the eclipsing variables are only a sub-group of the spectroscopic doubles. If spectroscopic doubles originate by fission, the point of transgression is probably not identical for the different doubles and the diagram suggests that this transgression may occur along a considerable interval of the stellar rotation curve. R. C. F.

1851. Variable Lines of Hydrogen in the Spectrum of 52 π Aquarii. W. J. S. Lockyer. *Astrophys. J.* 73. *pp.* 55–57, *Jan.*, 1931.—In response to Higgs' request [see Abstract 781 (1931)] for some recent history of this star by other observers, the results secured by me from photographs taken at the Norman Lockyer Observatory at Sidmouth are here given. The observations made here corroborate the great change which has taken place in the spectrum from 1928 up to May 1930, as recorded by Higgs. These observations, however, which suggest a period for this star of approximately 1194 ± days, cannot be reconciled to the estimates of relative intensity as recorded by him for the years 1915 and 1919. AUTHOR.

1852. Possible Building Up of Elements in Stars. Criticism of the Theory of Atkinson and Houtermans. W. Anderson. *Zeits. f. Physik,* 67. 3–4. *pp.* 294–295, *Jan.* 12, 1931.—The author reviews the conditions at the centre of a star on the Atkinson-Houtermans theory [see Abstract 2707 (1929)] and shows that this is in disagreement with Milne's latest investigation which finds a central stellar temperature which may exceed 10^{11} degrees and a maximum density which is greater than that generally possible for ionisation (Pokrowski gives the upper limit for density as about $4 \cdot 10^{13 \pm 1}$ g./cm.^{3}). The average temperature speed at 10^{11} degrees for the helium nucleus is about $2 \cdot 5 \times 10^9$ cm./sec., and for the quickest α-particle only $2 \cdot 06 \times 10^9$ cm./sec.; the number of collisions, moreover, being much greater with a density of 10^{13}g./cm.^{3} than of 10g./cm.^{3}. The conclusion (analogous to the identity of liquid and vapour under great pressure at a critical temperature) is drawn for gas ionisation that under pressure of $3 \cdot 5 \times 10^{12}$ dym./cm.^{2}, the ionisation potential of hydrogen is nil, and the paradoxical statement results that the electrons, though all of them are bound, are free. Under the prodigious pressure entailed by a density of 10^{13} g./cm.^{2}, not only all atoms are "mechanically" ionised, but even all atomic nuclei are "mechanically" dissociated; the difference between dissociated and associated conditions having vanished. A. S. D. M.

LIGHT.

1853. Methods of Measuring Colours. C. Schaefer and H. Pese. *Phys. Zeits.* 32. *pp.* 1–16, *Jan.* 1, 1931.—An attempt is made to find the connection between Ostwald's method of measuring and classifying colours, and that of spectral colour theory. The significance of Ostwald's colour atlas is discussed, and the validity of his theorem relating to his colour disc (*Satz vom Farbenhalb*) is tested. Ostwald's scheme is found to give good agreement with the results of exact colour theory in only about half of all the possible cases. It is found impossible to transform the Ostwald colour components generally into those of the exact theory; nevertheless his method is of practical utility over a certain range of colours. The paper contains numerous instances of colour analysis, and the results obtained by the different methods are compared. Reasons are given for considering the Ostwald factors " white content " and " black content " disadvantageous for defining colour components. [See also Abstracts 3305 (1929) and 422 (1931).] H. L. B.

1854. Colorimetry of Pigments and a Suggested Scale of Fastness. G. F. New, G. S. Disney and D. L. Tilleard. *Oil and Colour Chem. Assoc., J.* 14. *pp.* 3–44; *Disc.*, 44–48, *Jan.*, 1931.—Tests were made with a Guild colorimeter in which the primary colours are red $0{\cdot}700\,\mu$, green $0{\cdot}536\,\mu$ and blue $0{\cdot}436\,\mu$, and white is that obtained with black body radiation at 5000° K. Maxwell's system of coordinates was employed for the specification of the colours. The preparation of pigments is examined in detail to find the effects of extraneous factors, the influence of the solid diluent, its nature and the degree of dilution, the influence of the medium employed and of the thickness of the film. It is recommended that for standardised routine tests the maximum possible thickness should be used. The rate of fading is examined for different pigments and under different conditions. In testing, a carbon arc is preferable to sunlight, while 250 hours is sufficient to determine the relative fastness. Personal and instrumental errors are examined. In the *Discussion*, **H. J. Stern** suggested photoelectric methods to record values and avoid human errors, while humidity and roughness of the surface may affect fading; **F. J. Tritton** referred to particle size in the pigment affecting the results obtained. The author stated that a photoelectric cell must be calibrated in terms of the sensation curves for the average eye. R. S. R.

1855. Definition of Saturation. W. Seitz. *Phys. Zeits.* 32. *pp.* 112–114, *Jan.* 15, 1931.—A reply to criticisms of the author's previous paper made by Schaefer and Pese [see Abstract 422 (1931)]. C. B. A.

1856. Absorption of Aqueous Solutions of Tartaric Acid. R. Lucas and M. Schwob. *Comptes Rendus*, 192. *pp.* 225–227, *Jan.* 26, 1931.—In view of the discordant results of other investigators [see Abstracts 3965, 3966 (1930)] the absorption for ultra-violet light (λλ2654 and 2536) of solutions of tartaric acid from two different sources has been determined, using silica vessels and water distilled in a platinum vessel, and measuring the absorption photoelectrically [see Halban, Abstract 895 (1923)]. The absorptions show differences of over 100 % in the results for the two varieties used, and both smaller than previous results. They also show clearly that Beer's law is not followed, specific absorption being over 200 % greater for dilute than for concentrated solutions. C. A. S.

1857. Transformation of Light into Heat in Solids. Part I. J. Frenkel. *Phys. Rev.* 37. *pp.* 17–44, *Jan.* 1, 1931.—Starting from the analogy between a crystal and molecule, it is shown that the electronic excitation, forming the first step in the process of light absorption, is not confined to a particular atom, but is diluted between all of them in the form of "excitation waves," similar to sound waves which are used to describe the heat motion in the same crystal. Owing to the interaction between the atoms the excitation state is split up into substates whose number is equal to the number of atoms n (excitation multiplet). By superposing several excitation waves "excitation packets" can be constructed representing the travelling of the excitation state from one atom to another. To each excitation sub-state there corresponds a definite crystal structure (lattice constant, vibration frequencies) slightly different from that of the normal, and giving rise to slightly different vibrational states. This influence of the excitation on the vibrational states provides an indirect coupling between them, which allows the excitation energy to be shared between a few hundred heat-oscillators with practically no direct coupling nor anharmonicity in a radiationless transition which forms the second state of the process of light absorption. [See also Abstracts 1752 and 2202 (1930).] AUTHOR.

1858. Structure of the Field of View. T. Obonai. *Imp. Acad. Tokyo, Proc.* 7. *pp.* 19–22, *Jan.*, 1931. *In German.*—The paper contains results regarding the relation between sharpness of vision and the angular rotation of the object viewed, the results being set out graphically. It is shown that the sensitivity alters periodically in all four quadrants of the field of view. A summary is next given of a number of cases of optical deception with inclined and intersecting lines. Finally a hypothesis is developed to explain these facts. R. S. R.

1859. Light Transmitted in "Total Reflection." A. de Gramont. *Comptes Rendus*, 192. *pp.* 40–43, *Jan.* 5, 1931. *Rev. d'Optique*, 10. *pp.* 105–116, *March*, 1931.—A beam of light is allowed to fall on the face of an isosceles right-angled prism, so that it is "totally reflected" from the hypotenuse face. The prism is placed on a photographic plate, the beam being brought as near as possible to this. A feather of light passes out at the hypotenuse, to which it is strongly inclined, and records itself on the photographic plate. The intensity of this light, and its polarisation, have been measured in the plane of incidence, and in the plane at right angles to this, with polished, dull and ground surface. Details are given of the variations which have been observed. H. N. A.

1860. Prism Size and Orientation in Minimum Deviation Refractometry. L. W. Tilton. *Bureau of Standards, J. of Research*, 6. *pp.* 59–76, *Jan.*, 1931.—Investigations show that marginal aberration often impairs seriously the advantages which should result in using larger apertures and larger prisms in accurate refractive index measurements. Frequently the ratios of probable error do not exceed 1/30 in pointing to the limit of angular resolution. For determinations to 10^{-6} μ by minimum deviation measurements with a 60° prism the most suitable length of prism face for all transparent media is 2 cm. Systematic errors in μ due to improper orientation of a prism for minimum deviation are discussed.

Residuals in prism azimuth found by hand and eye adjustment have an approximately normal distribution, and are almost constant on the average with wave-length. The requisite precision in azimuthal orientation is quantitatively established, and the corresponding tolerances for prisms having various indices and refracting angles are given by curves. These curves may be used to evaluate prism-orientation corrections to index measurements. R. S. R.

1861. Molecular Refraction of Solutions of Boric Acid in Glycerin. M. Morelli. *Accad. Lincei, Atti*, 12. *pp.* 451–456, *Nov.* 2, 1930.—The molecular and specific refractivities of boric acid in glycerin solutions diminish as the concentration of the solutions increases, the variations being more marked for the n than for the n^2 formula. The values obtained are greater than for aqueous solutions. Glycerin solutions of boric acid are formed with increase in volume, the extent of this growing appreciably with the concentration of the solution; the formation of aqueous solutions is, on the other hand, accompanied by contraction. T. H. P.

1862. Refractive Indices of Heavy Metal Halides in the Visible Region. H. Schröter. *Zeits. f. Physik*, 67. 1–2. *pp.* 24–36, *Jan.* 12, 1931.—The preparation of single crystals of AgCl, AgBr, TlCl and TlBr is described and also the preparation of prisms from these crystals. The refractive indices in the visible were determined by the prism method and the values are tabulated. Constants of dispersion formulæ for interpolation of values are then discussed. F. S.

1863. Refractive Indices of Hydrogen, Oxygen, Argon and Nitrogen. J. Tausz and H. Görlacher. *Zeits. f. techn. Physik*, 12. 2. *pp.* 123–126, 1931.—In continuation of the previous paper [see Abstract 1513 (1931)] it is shown that the refractive indices of hydrogen, oxygen, argon and nitrogen calculated from Lorentz dispersion equations are in good agreement with the observed values. C. B. A.

1864. Photoelastic Dispersion of Vitreous Silica. L. N. G. Filon and F. C. Harris. *Roy. Soc., Proc.* 130. *pp.* 410–431, *Jan.* 1, 1931.—The dispersion of the double refraction induced by stress was investigated in vitreous silica, a substance of glassy type containing only a single chemical constituent and in which the complications arising from progressive creep are absent. Two rectangular blocks of vitreous silica were examined. The method of measurement of the stress-optical coefficient C (the difference per unit stress of the indices of refraction for light polarised in and perpendicular to the line of stress) was identical in principle with the spectrometer method previously used by Filon, but with an important modification which greatly increased the accuracy of the method. If $r(\lambda)$ is the retardation produced by the specimen in light of wave-length λ, the spectrum observed is crossed by dark bands whose centres are given by the equation $r(\lambda) = n\lambda$, n being an integer. The object of the experiment is to determine the form of $r(\lambda)$. Denoting by C′ the stress-optical coefficient calculated from the formula $C = C_0/(1 - \lambda_0/\lambda)$, C denoting the observed ratio of retardation to stress per unit thickness, C − C′ showed a change from + to − on passing from λ4900 to λ5100. Various series of observations are recorded in tables giving the values of λ, C, C′, and C − C′, and the values of C − C′ are plotted to λ. A curve through the first set of observations exhibits their most marked characteristics, of which the chief is the rise of the curve at about λ4800 and its gradual fall to a minimum at about λ5100 followed by a subsequent rise. The curves show many oscillations and irregularities. There are indications that for comparatively moderate pressures the retardation in silica is not strictly proportional to the applied load, a result of very great importance, as it contradicts one of the fundamental assumptions of photoelastic theory. The observations do not exclude the hypothesis that the remarkable local irregularities in the curve of photoelastic dispersion of silica may be directly connected with the natural periods of silicon. J. J. S.

1865. Mechanical Double Refraction of Liquids in Relation to Molecular Form. D. Vorländer and U. Kirchner. *Zeits. f. phys. Chem.* 152. *Abt. A.* 1–2. *pp.* 47–66, *Jan.*, 1931.—By an improved modification of the method previously described [see Abstract 706 (1926)] measurements of the double refraction produced by strain are extended to a long series of liquids comprising the following classes: aliphatic and aromatic anisotropic oils, homogeneous mixtures of anisotropic oils, solutions of colloids in anisotropic oils, and aqueous solutions of inorganic and organic salts. The original paper should be consulted for the description and discussion of the results in each case. C. B. A.

1866. Elliptic Polarisation by Reflection at the Surface of Liquids with Reference to Monomolecular Layers. C. Bouhet. *Ann. de Physique*, 15. *pp.* 5–130, *Jan.*, 1931.—Ellipticities (E), measured with de Chaumont's apparatus with the green line of mercury, have been determined for water (0·00040), nine liquid fatty acids and 29 other organic liquids, and reasons for differences from previous results given. $E/(n-1)$, n being refractive index, varies inversely with the surface tension. Ellipticities of the fatty acids vary little with the number of carbon atoms, being proportional to the diameters of the molecules as determined by X-rays. Ellipticities of salt solutions are identical with that of water, indicating an adsorbed surface layer of water as required by Gibbs' theory. Ellipticities of aqueous solutions of the not completely miscible fatty acids regularly decrease with increased length of chain, minimum ellipticity in each case being for a solution for which the area per molecule of acid is itself a minimum. These results agree with the theory of a vertically oriented surface layer of molecules. Detailed results with the C_{16} acid confirm Adam's conclusion as to two-dimensional vapour and liquid phases. The identity of structure of the Gibbs adsorbed layer on solutions of such acids with the monomolecular layer given by the higher insoluble acids is also confirmed. For pure liquids results are less definite, but point to a preferred orientation of the superficial molecules, extending some distance below the surface. [See Abstract 118 (1930).] C. A. S.

1867. Method of Measuring Circular Dichroism. J. P. Mathieu. *Comptes Rendus*, 192. *pp.* 156–158, *Jan.* 19, 1931.—Circular dichroism is measured by means of an ordinary half-shadow polarimeter in which a compensating plate of a birefringent crystal can be introduced between the substance under investigation and the analyser, so that both rotation and dichroism can be measured on the same instrument. The theory of the method is given, as well as the conditions for the choice of the compensator. C. B. A.

1868. Transmitted Structural Blue in Microscopic Objects. C. W. Mason. *J. Phys. Chem.* 35. *pp.* 73–81, *Jan.*, 1931.—Qualitative experiments are described which show that uniformly-sized particles finer than $0 \cdot 4\ \mu$ scatter light inversely as λ^4. They exhibit Tyndall blue and transmit yellow. Between $0 \cdot 4\ \mu$ and $0 \cdot 7\ \mu$ red is scattered and blue diffracted in maxima at such angles that they can be resolved in blue light. In a medium of widely different refractive index the particles transmit blue and scatter yellow. Particles coarser than $0 \cdot 7\ \mu$ diffract all wavelengths. If of good contrast they exhibit transmitted blue, when the aperture of the objective is suitably adjusted. Transmitted blue is visible to the naked eye with specimens coarser than $0 \cdot 4\ \mu$, owing to the greater deviation of red than blue, by scattering or diffraction. C. B. A.

1869. Measurement of Turbidity. H. Sauer. *Zeits. f. techn. Physik.* 12. 3. *pp.* 148–162, 1931.—The intensity of the light scattered by homogeneous layers of a turbid medium is calculated, taking into account absorption of primary and scattered light, but neglecting scattering of higher order. The scattering formula is discussed for such special cases as are of importance in the practical measurement of turbidity and fluorescence. The change in the scattering effect of a turbid layer in comparison with scattering by a single particle is considered, and is calculated for the case of the Rayleigh law. A rational standard of turbidity for practical measurements (nephelometer determinations of concentration) is suggested, and its application to measurements with the Zeiss instrument for measurement of turbidity is indicated. C. B. A.

1870. Scattering Effect of Plates with Irregular Surfaces. A. Buchbinder. *Zeits. f. techn. Physik.* 12. 3. *pp.* 162–164, 1931.—A mathematical investigation of the light-scattering effect of plates with surfaces having slight indentations such as are used in searchlights. C. B. A.

1871. Determination of Thickness of Thin Transparent Crystal Films. G. Bauer. *Ann. d. Physik,* 8. 1. *pp.* 7–46, *Jan.* 26, 1931.—The first part of this paper consists of a mathematical investigation of the Wiener method of determining the thickness of thin films, its accuracy and the conditions of its use, and the necessary corrections, being discussed. In the second part, the method is applied to the measurement of absorption in simple crystals, the technique being extended to films *in vacuo.* Examples are given of the application of some of the results obtained in the first part; and also a modification of the method to measure the refractive dispersion of lead chloride into the region of its absorption. C. B. A.

1872. The Spierer Lens. W. Seifriz. *J. Phys. Chem.* 35. *pp.* 118–129, *Jan.,* 1931.—The Spierer lens is an oil-immersion objective in which is inserted a mirror, smaller than the lens, which reflects all direct light coming into the objective. Scattered light is picked up by the lens around the mirror. The structure of cellulose (and protoplasm) as revealed by the Spierer lens is that of tiny rods or super-micelles, arranged end-to-end to form long and parallel striæ. AUTHOR.

1873. Plano-Convex Aspherical Lens. G. B. Pacella. *Accad. Lincei, Atti.* 12. *pp.* 436–438, *Nov.* 2, 1930.—A discussion and solution are given of the problem of finding the form to be assigned to a non-spherical lens with a plane face so that it may be stigmatic for the point at infinity on the axis when a beam of monochromatic light falls upon it. J. J. S.

1874. Standard Transformations of Sliding and Their Applications to Geometrical Optics. C. Carathéodory. *Accad. Lincei, Atti,* 12. *pp.* 353–360, *Nov.* 2, 1930.—The author shows how by a simple inspection of the classical formulæ of standard transformations in mechanics a geometrical study can be made under a different form from that ordinarily used. It is shown that the transformation which the luminous rays undergo in passing through an instrument can be represented on account of the Huyghen's principle by a generalised transformation of this type. This treatment also supplies the simplest method of defining the eikonal function of Brunn, the necessary equations for the deformation of a caustic, and the generalisation of the Bruns-Klein theorem. It applies not only to the ordinary problem of the calculus of variations, but to the problem of Lagrange. R. S. R.

1875. Wave Theory of Astigmatism of Optical Systems. J. Picht. *Zeits. f. Instrumentenk.* 51. *pp.* 19–28, *Jan.,* 1931.—The paper forms an extension of the procedure followed in earlier papers [see Abstracts 1402 and 1404 (1930)], and mathematical expressions are obtained for the astigmatism of an optical system. The results are also set out graphically to illustrate the astigmatism obtained. R. S. R.

1876. Numerical Formulæ for Optical Systems. H. R. Schulz. *Zeits. f. techn. Physik,* 12. 3. *pp.* 178–179, 1931.—Reference is made to recent work by Berek and Harting on calculations for an optical system and the knowledge of the action of the individual elements of the system. Harting applied the equations to the case of achromatic double lens systems. Using Harting's formulæ the author applies the results to different forms of objectives of the three-lens type. R. S. R.

1877. Measurement of Radius of Curvature by Autocollimation. A. Arnulf. *Rev. d'Optique,* 10. *pp.* 22–43, *Jan., and pp.* 69–72, *Feb.,* 1931.—The principles underlying the measurement of radii of curvature by autocollimation are first explained. Guild's methods are examined critically and methods discussed by which a higher degree of accuracy may be obtained, such as using objectives of sufficiently large aperture and avoiding the use of lycopodium powder to identify the surface. Prytz's method, which avoids errors due to the powder, is next examined, but the apparatus is complicated and the use of a biprism and only half the aperture of the microscope reduces the quality of the image. Three forms of apparatus are described and illustrated by diagrams and photographic plates for accurate determinations by autocollimation methods: (1) A microscope for concave surfaces giving an accuracy of 1 μ for radii 0–80 mm. It will eventually give an accuracy of 0·03 mm. for convex surfaces of radii 0–50 mm. (2) A small optical bench giving an accuracy of 1 μ for radii 0–500 mm. for concave surfaces, 1 μ for radii 0–80 mm. and 0·02 mm. for radii 80–200 mm. for convex surfaces. (3) An optical bench of length 4·5 m. in two forms giving an accuracy of 0·1 and 0·02 mm. respectively for radii 0–4500 mm. for concave surfaces. [See Abstracts 689 (1922) and 2438 (1929).] R. S. R.

1878. Polishing of Surfaces. J. M. Macaulay. *Roy. Techn. Coll. Glasgow, J.* 2. *pp.* 378–384, *Jan.,* 1931.—After consideration of various opinions held with regard to the nature of surface polish, a theory advanced in 1926 is referred to, *viz.,* that in the process of polishing, the surface material is actually raised to its melting temperature. A number of experiments are then described showing that if such substances as red lead (Pb_3O_4), lead dioxide (PbO_2) and chalk ($CaCO_3$) are used as polishing powders, they become changed to lower oxides, litharge (PbO), etc., or to lime (CaO). This may be considered as more or less direct evidence of high temperatures during the polishing process. AUTHOR.

1879. Spherical Aberration with Many Coefficients. J. Picht. *Zeits. f. techn. Physik*, 12. 3. *pp.* 180–182, 1931.—A system of equations is developed to express the wave surface as a function of the direction (axial angle and azimuth) of the light ray. The corresponding wave surface coefficients are then obtained from the coefficients of the spherical aberration of length. The integral production of the theoretical refraction of the components of the Hertz vectors is stated, and finally the volume function is given as a function of the axial angle of the light rays. R. S. R.

1880. Improved Balloon Theodolite. Kölzer. *Zeits. f. Instrumentenk.* 51. *pp.* 37–38, *Jan.*, 1931.—The disadvantage possessed by the earlier type of this instrument [see Abstract 3542 (1929)], in which the object observed is lost sooner in an illuminated field of view, is avoided. The brightness of the metal filament of the lamp is reduced by means of a resistance as the image seen in the field becomes less bright. Night balloons have then been followed to 10,000 m. on many occasions, and to 12,700 m. as a maximum. R. S. R.

1881. Theory of the Bosshardt Zeiss Double Image Tachymeter. V. Theimer. *Zeits. f. Instrumentenk.* 51. *pp.* 44–48, *Jan.*, 1931.—It has been pointed out to the author by v. Gruber that the multiplication constant of the apparatus [see Abstract 439 (1931)] is not exactly equal to 100, as he assumed in his original paper. This error can be eliminated by means of the cover glass in front of the rotating wedge. This cover glass itself is very slightly wedge-shaped. The author also gives a method of calculation for testing and correcting the multiplication constant. Some other points in connection with the adjustment and use of the instrument are dealt with. H. N. A.

1882. Illumination of Surfaces by Optical Systems. R. Straubel. *Zeits. f. techn. Physik*, 12. 3. *pp.* 129–133, 1931.—The author considers a system such as that of the projection lantern, assuming screens of different forms and light sources giving different candle-power distributions. The paper is mainly mathematical. J. W. T. W.

1883. Microscopic Method. E. H. Synge. *Phil. Mag.* 11. *pp.* 65–80, *Jan.*, 1931.—The author has already suggested a method for increasing microscopic resolution, in which he investigates the opacity of a microscopic section by means of a spot of intense light, with dimensions small in comparison with a wave-length. Great difficulties, both practical and theoretical, are met with in realising this, and a method is now proposed which it is thought may prove to be satisfactory. A solid ellipsoid of glass, with very small eccentricity, is partially silvered outside, and at one of the foci there is a small colloidal particle of gold (of the order of 10^{-6} cm.). This is illuminated by means of an intense beam of light from a small source, condensed by a lens outside the sphere; and it is shown that, owing to the fact that the light from it is reflected from practically the whole surface of the sphere, an image will be formed at the other

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focus F_2 which, though somewhat larger than the colloidal particle, will be small in comparison with a wave-length. A cylindrical hole is to be drilled into the sphere, so as to penetrate a little beyond the focus F_2, and a rod of the same glass as the sphere can be introduced into this. A small microscopic section is attached to this rod and can be brought to the focus F_2. The space between the rod and the hole is to be filled with an immersion fluid having the same refractive index as the ellipsoid. A collecting lens outside the ellipsoid brings the rays emerging from F_2 to a focus, as a diffraction disc, at a point p, where the intensity can be measured photoelectrically. The microscopic section would be moved step by step across F_2, and a picture could be built up showing the differences of opacity as in telephotography. H. N. A.

1884. Photometric Efficiency of an Optical System. V. Ronchi. *Accad. Lincei, Atti,* 12. *pp.* 663–667, *Dec.* 21, 1930.—The brightness of the image of a large distant object seen through an optical system such as a telescope varies with (*a*) the area of the exit pupil, (*b*) the loss of light by internal reflection from the surfaces of the elements, (*c*) the absorption of light at reflecting surfaces, (*d*) the absorption within transmitting media, (*e*) the loss due to diffusing or opaque particles (*e.g.* dust). It also depends on the perfection of the system as an image-forming device. The first factor can be calculated, and the remainder, taken together, may be measured photometrically and called the "photometric efficiency" of the system. The method of measurement proposed by the author is that of extinction. An extended surface of variable brightness is viewed, first through an instrument of known photometric efficiency, and then through the system under test. The brightness of the image is brought down to the threshold of visual sensitivity by the interposition of a pair of crossed nicol prisms. If the angles between the prisms are α_1 and α_2 in the two cases, the photometric efficiencies are in the ratio $\sin^2 \alpha_1$ to $\sin^2 \alpha_2$. The author concludes by giving some numerical examples of the application of the method. J. W. T. W.

1885. Brightness of Luminous Surfaces Formed by Optical Systems. H. Joachim. *Zeits. f. techn. Physik,* 12. 3. *pp.* 133–142, 1931. —A mathematical treatment of the flux distribution problems in image formation by optical systems. The following results are obtained: (1) the brightness of object and image viewed in the direction of conjugate rays is the same, apart from transmission losses; (2) for a system in which the sine-condition is fulfilled, a perfectly diffusing object surface gives an image of uniform brightness (*i.e.*, one obeying Lambert's law); (3) for a system giving unit magnification, the brightness distribution as regards direction is the same for image and object; when the distribution is not uniform for the object, magnification greater than unity increases the departure from Lambert's law and *vice versa.* A form of geometrical construction is described by means of which the brightness distribution curve in the image space may be found from that for the object space. The effect of the optical system in acting as a stop has to be taken into account. J. W. T. W.

1886. Photometric Properties of Rough and Frosted Glasses. J. Dourgnon and P. Waguet. *Comptes Rendus,* 192. *pp.* 155–156, *Jan.* 19, 1931.—Measurements of the transparency of commercial diffusing glasses show that the maximum transmission is obtained in the direction of the incident beam when this falls on the rough face, but that when the smooth face is towards the incident light, the maximum is in a direction much nearer the normal. The proportion transmitted decreases with the angle of incidence. For nearly normal incidence, the transmission factor is largest when the light is incident on the rough face, whereas for very oblique incidence the reverse is true. C. B. A.

1887. Theory of the Photometric Integrator. A. Buchbinder. *Zeits. f. techn. Physik,* 12. 3. *pp.* 164–167, 1931.—The author first recapitulates the ordinary theory of the photometric integrator, generalised so as to be independent of the form of the diffusing surface. He then applies the condition that the illumination due to the light which has been once or more often reflected shall be independent of the position of the surface at which the illumination is measured. He shows that the only surface which satisfies this condition is the spherical surface, so that this is the only form of integrator which fulfils the requirements of the photometric device known as the Ulbricht sphere. J. W. T. W.

1888. Shadow Effects in Photometry, Especially with Photoelectric Cells. L. Piatti. *N. Cimento,* 8. *pp.* 29–38, *Jan.,* 1931.—The author points out that if an opaque body be placed between the light source and the photometric comparison surface it illuminates, the inverse square law no longer holds. He calculates the effect for the ideal case of a point source illuminating a circular disc which is partially shaded by a coaxial circular disc at a given distance in front of it. The formula obtained is verified by experimental work with a source of finite dimensions. The author points out that in most photoelectric cells the sensitive surface is shaded to a greater or less extent by the loop or grid used as an anode. If the cross-section of this anode is not negligible compared with the illuminated area of sensitive surface, the application of the inverse square law may lead to errors if the lamp illuminates the cell by direct light. Similarly the use of gauze screens as reducing media in photometry may be objectionable on the same grounds. J. W. T. W.

1889. New Photographic Effect. F. E. Poindexter. *J.O.S.A.* 21. *pp.* 59–69, *Jan.,* 1931.—A comprehensive discussion of the problem of latent image formation, and especially of the work of Trivelli and Sheppard. Experimental work is then described wherein the application of pressure to a photographic emulsion is found to prevent the formation of a latent image to a remarkably large extent. Whilst it is conceded that this experimental result is no better than others mentioned in support of a photomechanical hypothesis, nevertheless it is very direct since there is little doubt that high pressures should tend to prevent such a disintegration. It is postulated in the speculations which led to this work that light is a wave in the gravitational field of matter originating in the elastic segmental vibrations of the atoms and molecules. The paper is well illustrated. H. H. Ho.

1890. Photographic Reversal and the Sensitivity of the Silver Halide Grain. F. E. E. German and D. K. Shen. *J. Phys. Chem.* 35. *pp.* 93–99, *Jan.,* 1931.—This paper contains a long discussion of the subject and experimental evidence is given to show that the undevelopability of 83 % of the grains in two extreme functions containing the largest and smallest grains cannot be due to the depletion of the sensitivity promoting material in the solution, and also that there is no appreciable difference

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in sensitivity between the large and small grains of the same emulsion. It is stated that the terms sensitisers and desensitisers should be assigned to those substances which increase or decrease the developability of the grains. Substances which increase or decrease the speed should be called accelerators and retarders respectively. The rôle of a sensitiser is found to be that of preventing or delaying reversal. H. H. Ho.

1891. Photography of Waves and Vortices Produced by the Discharge of an Explosive. D. B. Gawthrop, W. C. F. Shepherd and G. S. J. Perrott. *Frank. Inst., J.* 211. *pp.* 67–86, *Jan.*, 1931.—In previous papers by the authors [see Abstract 1652 (1930)] data were given on the speed of propagation of the disturbance across a gas gap separating two cartridges when one of them—the " initiator "—is exploded by a detonator, and the second—the " receiver "—is detonated by influence. The present paper describes preliminary experiments in which the phenomena sent out by the detonation of a charge of explosive have been photographed by the Schlieren method, in which the wave phenomena are made visible by an optical device. Speeds at any point of the shock-wave flame, and of particles of products, etc., are readily calculated, and their relative positions at all times are shown on the photograph. The records are permanent. Certain fundamental differences are exhibited in the photographs between the waves sent out from (1) a small unconfined charge of explosive and (2) a small charge of explosive confined in one end of a cellophane tube. The apparatus is described in detail with the idea that this method of photography may be readily applied to any problem in which small changes of optical density occur. T. B.

1892. Fluorescence of Zinc Vapour. W. Kapuscinski. *Acad. Polonaise. Sci. et Lettres Bull.* 9–10*A*. *pp.* 453–459, *Nov.–Dec.*, 1930. *In German.*—The zinc vapour was obtained in a quartz vessel at a high temperature, great precautions being necessary to ensure the cleanliness of the vessel and the purity of the vapour. The source of exciting light was the condensed spark, the Cd spark being by far the most effective. The fluorescence shows similarity with that of Cd vapour. The excitation region is round about the principal absorption line 2138·6 Å., which accounts for the strong effect of the Cd spark which has a very strong line at 2144·4 Å. The Zn vapour spectrum consists of lines and bands stretching from 2130 to 4900 Å, the lines corresponding to some of ZnI. The appearance of the lines and bands with increasing pressure is described in detail along with the relation between their intensities and that of the exciting light, and with the effect of impurities. A table showing the band maxima is included, and a short discussion of the mechanism of excitation is given for the various lines and bands. J. E.

1893. Decay Time of a KCl-Phosphor Containing TlCl and its Dependence on Temperature. W. Bünger and W. Flechsig. *Zeits. f. Physik*, 67. 1–2. *pp.* 42–53, *Jan.* 12, 1931.—A method is given of preparing KCl-phosphors containing slight admixtures of thallium chloride, and such that their emission dies down according to a simple exponential law: $L = I_0 . e^{-\alpha t}$. The logarithm of this constant α is a linear function of the reciprocal of the temperature, but is independent of the exciting and the emitted wave-length. Hence it may claim to have the physical significance of a decay-constant instead of being merely a formal constant introduced by interpolation. From the way in which the decay constants depend on temperature it is possible to calculate a threshold value in the sense of van't Hoff's equation, provided certain specified conditions are fulfilled. In this case crystalline absorption should occur corresponding to the calculated threshold value. This has been confirmed by extinction measurements. The author also gives a method of obtaining photographic records of spectrally dispersed phosphorescence. H. L. B.

1894. Ultra-Violet Absorption Spectrum of Lignin Derivatives. E. Hägglund and F. W. Klingstedt. *Zeits. f. phys. Chem.* 152. *Abt. A.* 3–4. *pp.* 295–312, *Jan.*, 1931.—Quantitative investigation of the ultra-violet absorption spectra, at wave-lengths between 3800 and 2480 Å., of aqueous and alcoholic solutions of alkyl lignins, lignosulphonic acids, and alkali lignins, derived from various types of wood, indicate that the same fundamental structure exists in all these substances. Derivatives of leaf-bearing trees and of conifers are sharply differentiated by the intensity of the transmission in the middle ultra-violet and by the position of the longer wavelength absorption band. Selective absorption is relatively pronounced. The results obtained definitely exclude the possibility of a purely aliphatic structure for lignin, and suggest that there must be at least one aromatic ring present, in accordance with the high refractive index and with various chemical properties. H. F. G.

1895. Influence of the Crystal Lattice on the Absorption Spectrum of a Compound. H. Fesefeldt. *Zeits. f. Physik,* 67. 1–2. *pp.* 37–41, *Jan.* 12, 1931.—The absorption spectra of crystalline silver iodide and thallium iodide for temperatures above and below their transition points (at which a colour change occurs) are worked out by means of photoelectric photometry. The change in the shape and position of the photometric curves is determined. A method of producing clear layers of silver iodide in an atmosphere of argon is described. Measurements show that at low temperatures (− 183° C.) the absorption spectrum is very little different from that at ordinary temperatures, whereas in the case of the simple ionic lattices of the alkali halides the bands appear considerably sharpened at − 183° C. H. L. B.

1896. Ultra-Violet Spectrophotometry: Comments on Apparatus and Experimental Methods. G. E. Davis and C. Sheard. *J.O.S.A.* 21. *pp.* 47–58, *Jan.*, 1931.—A simple and satisfactory type of container for the under-water spark, with suitable electrical circuits, and a new type of quartz cell to contain the liquids under examination are described. Some points are presented concerning the use of the under-water spark and the methods of obtaining data with the quartz spectrograph, and Hilger rotating sector photometer. Desirable modifications of the usual apparatus are suggested in order to increase the rapidity of the method and enhance its field of usefulness, particularly in the study of unstable solutions with varying transmissive properties. AUTHORS.

1897. Application of the Resonance Radiometer to the Reflection Spectrum of Quartz. J. D. Hardy and S. Silverman. *Phys. Rev.* 37. *pp.* 176–181, *Jan.* 15, 1931.—The reflection spectrum of quartz has been previously studied by means of both the rock-salt prism spectrometer and the echelette grating spectrometer. Early investigators have shown that for crystalline quartz, with the reflecting surface perpendicular to the optic axis, there is a double reflection maximum, one lying at $8 \cdot 4\,\mu$ and the other at $8 \cdot 9\,\mu$; and that fused quartz exhibits a single maximum at 8·8 μ. These regions have been studied under high dispersion by the authors using an echelette grating spectrometer. The high resolving power that was obtained was due to the sensitivity of the radiometric device, the resonance radiometer, which was first described by A. H. Pfund. The complete theory of the instrument was developed by one of us [see Abstract 195 (1931)]. By the use of this large resolving power and dispersion it has been possible to show that these spectra are considerably more complex than were found previously. The usefulness of magnesium oxide as a filter for excluding the higher orders of lower wave-lengths has been tested with gratifying results. AUTHORS.

1898. Infra-Red Spectra of H_2O, H_2S and H_2Se. W. Mischke. *Zeits. f. Physik*, 67. 1–2. *pp.* 106–126, *Jan.* 12, 1931.—The range of wave-lengths from 0·8 μ to 18 μ was examined with a prism spectrometer employing prisms of quartz, fluorite, rock-salt and sylvine. In the case of H_2S, besides the bands found by Coblentz, further bands were found at 1·57 μ, 1·92 μ and 14·6 μ, the last being very intense. Four bands were found in the case of H_2Se at 2·3 μ, 3·33 μ, 4·25 μ and 8·5 μ, which has a complicated fine-structure. The results are discussed in relation to the structure of the H_2O, H_2S and H_2Se molecules. F. S.

1899. Interferometric Measurements in the Arc Spectrum of Iron. C. V. Jackson. *Roy. Soc., Proc.* 130. *pp.* 395–410, *Jan.* 1, 1931. —Ten lines in the spectrum of the iron arc in air between λ4000 and λ4400 were measured by interferometric comparison with the red line of Cd or with the secondary standards of Ne. The results are in almost perfect agreement with the wave-lengths recommended by the International Astronomical Union in 1928, the mean systematic difference being only + 0·0003 Å., while the mean accidental difference is ± 0·0006 Å. The results and also the wave-lengths of 68 lines in the spectrum of the iron arc in air between λλ2300 and 3100 similarly measured are given in tables in which the results found by some other observers are given for comparison. The results found for the 68 lines agree well with the vacuum arc measurements of Burns and Walters. There is good agreement with the computed values for the arc in air given by the I.A.U. in 1928, and also with certain wave-lengths calculated by the author from energy levels given by Babcock. Five lines of mercury in the ultra-violet were also measured. J. J. S.

1900. Spectrographic Estimation of Chromium in Ruby. J. Papish and W. J. O'Leary. *Indust. and Engin. Chem.* 3. *pp.* 11–13, *Jan.*, 1931.—The persistent lines of chromium in the arc were determined both for solutions and in fused alumina using a quartz spectrograph and the results recorded in tables. The range studied extends from 5785·8 Å. to 3120·4 Å. Application of the results to artificial and natural rubies shows the chromium content of the former to be considerably greater. F. S.

1901. Formation of Molecular Ions of Helium. E. Majorana. *N. Cimento*, 8. *pp.* 22–28, *Jan.*, 1931.—The singly-charged helium ion, formed from a neutral helium atom and one having a positive charge, is studied theoretically by Heitler and London's method. The results are numerically in agreement with experiment. J. H. A.

1902. Spectrum of Helium. E. Majorana. *N. Cimento*, 8. *pp.* 78–83, 1931.—Two new rays, 320·4 and 357·5 Å., in the spectrum of helium are attributed by Kruger [see Abstract 467 (1931)] to anomalous terms $(2p)^{23}P_{012}$ and $(2s)^{21}S_0$. Calculation of the energy and considerations of stability favour the former of these conclusions; but the latter is certainly erroneous on energy grounds, and besides, it appears improbable that this ray is due to atomic helium. A. D.

1903. Spectra of Doubly-Ionised Argon, Krypton and Xenon. S. C. Deb and A. K. Dutt. *Zeits. f. Physik*, 67. 1–2. *pp.* 138–146, *Jan.* 12, 1931.—The analysis of the spark spectra of doubly-ionised argon, krypton and xenon is discussed with reference to the law of reversed doublets due to Millikan and Bowen, and the law of horizontal comparison proposed by Saha and Majumdar. The following values of the respective deepest terms (cm.$^{-1}$) and ionisation potential (volts) are deduced: A++, 297,675, 36·75 volts; Kr++, 252,963, 31·23 volts; Xe++, 230,958, 28·51 volts. These ionisation potential values are in good agreement with the respective values, 35·8, 30·8 and 27·1 found experimentally by Déjardin. J. S. G. T.

1904. Spectrum of Trebly-Ionised Cerium (CeIV). J. S. Badami. *Phys. Soc., Proc.* 43. *pp.* 53–58, *Jan.*, 1931.—The spectrum of the condensed spark of cerium has been investigated in the ultra-violet, and doublet combinations in CeIV, in addition to those given by Gibbs and White, have been found. The $6^2P - 6^2D$ combination of LaIII also has been identified. Term values and ionisation potentials of LaIII and CeIV are calculated. AUTHOR.

1905. Spectrum of Doubly-Ionised Arsenic. K. R. Rao. *Phys. Soc., Proc.* 43. *pp.* 68–71, *Jan.*, 1931.—The doublet system of AsIII published by R. J. Lang [see Abstract 1193 (1929)] has been amended and extended in the light of fresh observations which have been made, and a scheme of terms has been evaluated. AUTHOR.

1906. Nitric Oxide δ-Bands. R. Schmid. *Zeits. f. Physik*, 64. 3–4. *pp.* 279–285, 1930.—The NO δ-bands have been photographed in the afterglow of active nitrogen mixed with air. The rotation analysis of the band δ(0·3) is given and the rotation constant of the bands for the $^2\Sigma$ initial level (vibration quantum number $n' = 0$) is calculated to be B_0 1955 cm.$^{-1}$. F. J. W.

1907. Negative Nitrogen Band at 3914 Å. Produced by Electron Impact. A. E. Lindh. *Zeits. f. Physik*, 67. 1–2. *pp.* 67–74, *Jan.* 12, 1931.—Measurements of the intensity distribution of the *R* lines in the negative nitrogen band at 3914 Å. show that the initial rotational terms conform to a Boltzmann distribution, since log p, where p is the rotational quantum number, is a linear function of $p(p + 1)$ under all conditions. The gas temperature, calculated from the Boltzmann function, is 551° C. at 150 volts and 596° C. at 175 volts, the current being 0·16 mA. The intensity of the head of the band as a function of the electron velocity has been investigated. The intensity-voltage curves exhibit three pronounced maxima, of which the significance, however, is not apparent. The effective cross-section of nitrogen has been calculated from the optical measurements, but the results show little agreement with those of previous workers, possibly as a result of secondary disturbances. H. F. G.

1908. Intensities of the Balmer Lines. L. S. Ornstein and H. Lindeman. Part II. *Zeits. f. Physik*, 67. 1–2. *pp.* 1–6, *Jan.* 12, 1931. —From the intensity relations discussed in a former paper [see Abstract 150

(1931)] the probabilities of excitation by electron collision for the first energy level of hydrogen are determined and compared with the formulæ of quantum mechanics given by Elsasser and Bethe. The criticism by Ladenburg and Kopfermann of the authors' first paper is discussed.

J. J. S.

1909. Intensities in the Mercury Arc Spectrum. E. Lübcke. *Wiss. Veröff. a. d. Siemens-Konzern,* 9. 2. *pp.* 246–251, 1930.—The intensities are observed in an evacuated mercury arc when the kathode and kathode space are cooled with water. It is found that the cooling privileges the intensity of lines belonging to the singlet system, and this gives an explanation of the colour change. In the case of singlet-triplet combination lines, those with initial singlet states are strengthened, and with initial triplet states weakened. Measurements of the distribution of the gas temperature and electron-temperature made on the same tube show that the former has little effect; the phenomenon is to be attributed to changes in the electron-temperature: *i.e.,* to alterations in the mean electron-velocity. It is concluded that higher electron-velocities are needed for excitation of the singlet lines than of the triplets. A. C. M.

1910. Intensity Distribution in the Mercury Triplet $2^3S_1—2^3P_{0,1,2}$. R. Frisch and P. Pringsheim. *Zeits. f. Physik,* 67. 3–4. *pp.* 169–178, *Jan.* 21, 1931.—A special form of discharge tube is described in which mercury vapour can be bombarded with electrons of known energy. When the excited vapour is illuminated with one of the mercury lines 5461 Å., 4358 Å. or 4047 Å., a fluorescent light of these three wave-lengths is emitted. The fluorescent spectrum was photographed and the plates measured with a recording photometer. The relative intensity of the three lines of the triplet is found to be independent of the exciting component line. It is concluded that the difference of life as found by Randall [see Abstract 3425 (1930)] cannot be correctly deduced from fine-structure measurements. F. S.

1911. Intensity Measurements on Multiplets of Mercury and Neon Excited by Electron Impacts (Correction). W. Ende. *Zeits. f. Physik,* 67. 3–4. *pp.* 292–293, *Jan.* 12, 1931.—In a previous paper [see Abstract 183 (1930)] errors have occurred in the intensity data given for the multiplets of Hg and Ne when the lines are excited by electronic impact. The errors concern the evaluation of the Hg triplets 5461 : 4358 : 4047 Å. and also the Ne spectrum, the dispersion having been incorrectly considered in both cases. A table of correct values is included.

H. H. Ho.

1912. Ratio between Amounts of the Isotopes of Boron Monoxide from Intensity Measurements in the Spectrum. A. Elliott. *Zeits. f. Physik,* 67. 1–2. *pp.* 75–88, *Jan.* 12, 1931.—Discusses the corrections which have to be made in calculating the ratio between the isotopes from the ratios between the intensities of the band spectra of molecules containing a given element. It is shown that in certain cases these corrections are important. Analogous bands of the β-systems of $B^{10}O$ and $B^{11}O$ have been measured, and the intensity ratio has been found to be different for different bands. It is shown that this is due to the fact that the probability of springs between the levels differs, for the two isotopes, to a different extent in different bands, and when a correction is made for these differences the ratio between the intensities becomes constant for all the bands, and so the ratio between the amounts of the isotopes can be obtained. The resulting atomic weight calculated for boron is $10\cdot794 \pm 0\cdot001$. H. N. A.

1913. Band Spectrum Intensities for Symmetrical Diatomic Molecules. Part II. E. Hutchisson. *Phys. Rev.* 37. *pp.* 45–50, *Jan.* 1, 1931.—In a previous paper [see Abstract 148 (1931)] the writer derived an approximate expression for intensities in the electronic vibrational bands of symmetrical diatomic molecules, based upon the Franck-Condon theory of transition probabilities. In the present paper the approximation is carried further, by removing the restriction that the oscillations be linear. An extended formula is given making use of the Schrödinger theory of perturbations. Calculations using this perturbation theory formula are carried out for the hydrogen absorption band spectrum. It is shown that the agreement with experiment is much improved over that obtained on the assumption of harmonic oscillations. Calculations are also made using Morse's potential function in which case the agreement is still further improved, especially for the higher transitions. AUTHOR.

1914. Evidence for a Beryllium Isotope of Mass 8 and Fine Structure Measurements in the BeH Bands. W. W. Watson and A. E. Parker. *Phys. Rev.* 37. *pp.* 167–175, *Jan.* 15, 1931.—An intense spectrogram of the λ4991 BeH band has been obtained in the third order of a 21-ft. concave grating with a dispersion of $1\cdot286$ Å. per mm. Every P and R line of the (0, 0) band in the strong interval $K'' = 6$ to 20 is accompanied by a very weak line in the position calculated for Be^8H, except where a strong line of another branch prevents measurement. The relative intensities of the Be^8H and Be^9H lines are about 1 : 2000. Discussion shows this to be a reliable indication of the presence of a small amount of a beryllium isotope of mass 8. This BeH band system is composed solely of the $\Delta v = 0$ sequence, with the band origins forming a head at the (4, 4) band, thus accounting for band origins on both sides of the (0, 0) origin in this same sequence. The doubling of the branches at the origin is observed, the relative intensities of the components being in complete agreement with those predicted for case *b* doublet states. The system represents a $^2\Pi \rightarrow {}^2\Sigma$ transition with $A = 1\cdot97$ cm.$^{-1}$ for the $^2\Pi$ state. Peculiar Λ-type doubling relations and the reverse bending of the branches for high K values are discussed. AUTHORS.

1915. Temperature Determinations from Band Spectra. Part I. Vibrational Energy Distribution and Vibrational Transition Probabilities in the Cyanogen $^2\Sigma - {}^2\Sigma$ Band Spectrum. L. S. Ornstein and H. Brinkman. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 33–41, 1931. —The intensity distribution in the violet cyanogen band system (electronic transition $^2\Sigma - {}^2\Sigma$) has been investigated, using a carbon arc. The maximum intensity of the band head was taken as the band intensity, and these intensities divided in each case by ν^4 are recorded for a number of bands, due to transitions from vibrational states n' to vibrational states n'', such as 0–2, 1–3, 2–5 . . . 6–8; 0–1, 1–2, 2–3 . . . 5–6; 0–0, 1–1 . . . 4–4; 1–0, 2–1, 3–2. For some of them the surface intensity divided by ν^4, as determined by a grating, is also recorded; these measurements showed satisfactory agreement with those made by the prism spectrograph. It is shown that a distribution of temperature exists in the arc for the vibrational levels, which, within the limits of experimental accuracy, is the same as for the rotational levels. This is not the case for BO excited in active N_2. The calculated temperature was 5870° Abs. The vibrational transition probabilities have been determined. In each sequence, after a certain value of *n′*, an exponential relation exists between transition probability and vibrational energy. H. N. A.

1916. Hyperfine Structure and Temperature Classification of the Stronger Lines of Columbium. A. S. King. *Mt. Wilson Observat. Contrib. No.* 416. *Astrophys. J.* 73. *pp.* 13–25, *Jan.*, 1931.—The paper gives the temperature class, the ionisation, and a preliminary discussion of the hyperfine structure of 646 of the stronger lines of columbium between λλ3100 and 6900. The results were obtained by comparing electric-furnace spectra at temperatures of about 2500° and 2900° C. with the spectra of the arc and spark. Approximately 200 lines appear in the furnace spectrum, but many neutral and all of the ionised lines require higher excitation. Much variation in response to excitation was found for lines in both groups. Of special interest is the large proportion of columbium lines having hyperfine structure. Of the lines listed, about 40 % are evidently complex. The patterns, for the most part unresolved, appear to consist usually of two, four, or six components, with some still more complex. As the wave-length increases, the spacing of hyperfine patterns becomes in general wider. Lines of complex structure occur in all temperature classes. AUTHOR.

1917. Hyperfine Structure of Mercury Resonance Line 2537 A. S. Mrozowski. *Acad. Polonaise Sci. et Lettres, Bull.* 9–10. *A. pp.* 464–503, *Nov.–Dec.*, 1930. *In German.*—The importance of hyperfine structure in problems of atomic physics (isotope effects and nuclear spin) is stressed, and recent work bearing on it is discussed in some detail. The mercury vapour spectrum, although the most extensively studied, is very complicated, and a simplification is found in studying the Zeeman effect in absorption, it being known that this corresponds in general with the emission spectrum. A low pressure mercury arc was used, with an electromagnet giving 7·5 kilogauss. By this means single components may be isolated for study. The mean absorption coefficient for the whole line is obtained as well as relative values for the components. The state of polarisation is very complicated, and has not been completely explained. J. H. A.

1918. Derivation of Hyperfine Structure Formulæ for One-Electron Spectra. G. Breit. *Phys. Rev.* 37. *pp.* 51–52, *Jan.* 1, 1931. —A short but rigorous derivation is given for the energy-level separations caused by a nuclear magnetic moment in a one-electron spectrum. Two of the formulæ are general. A formula is also given for weak coupling between the orbital angular momentum and the electron spin. AUTHOR.

1919. Two-Electron Spectral Terms. F. Paschen. *Preuss. Akad. Wiss. Berlin, Ber.* 32. *pp.* 574–578, 1930.—When more than one electron changes its orbit, complex (" dashed ") terms arise which can combine among themselves and with the ordinary simple terms of the spectrum concerned. For 2-electron spectra with ground state *ns ns* ^{1}S, simultaneous excitation of both electrons gives rise to terms such as *np np*, *np* (*n* + 1)S, *np* 3*d* and the like, until finally the doubly-excited state is reached.

Examples are given from the work of the author in the last year on HeI, BeI and AlII. The best arrangements of source to give such lines are discussed. A. C. M.

1920. Raman Effect in Pure Water and in Solutions. R. Brunetti and Z. Ollano. *Accad. Lincei, Atti,* 12. *pp.* 522–529, *Nov.* 16, 1930.—The Raman spectrum was studied from 3800 to 5900 Å. for water, hydrochloric acid, and a number of metallic chlorides and nitrates, using a mercury arc as source. It is agreed that each of the three bands is made up from at least two elements; the present authors find that there are three, with frequency shifts of 3225, 3469 and 3589 cm.$^{-1}$, in agreement with some, but not all, workers in this subject. The first two are generally considered to be associated with the absorption band of water at about $3\ \mu$, being due to two polymers of the compound, but the authors do not agree with this conclusion. J. H. A.

1921. Photophoresis and the Influence upon it of Electric and Magnetic Fields. F. Ehrenhaft. *Phil. Mag.* 11. *pp.* 140–146, *Jan.*, 1931.—Previous work on this subject is discussed at length, and the present state of complication has induced the author to attack the problem again from the experimental side, and in particular with respect to transverse photophoresis. Four experiments are described, *viz.*, transverse magneto-photophoresis, in which, by simultaneously adjusting a homogeneous electric field parallel to the homogeneous magnetic field [see Abstract 1113 (1928)], single particles of nickel, iron, antimony, etc., produced in an electric arc are observed to move in the concentrated beam in the direction of the magnetic lines of force, and hence perpendicularly to the illuminating beam, a movement, moreover, which is reversed on reversing the magnetic field; longitudinal magnetophotophoresis, which cannot be reversed by changing the direction of the magnetic field; transverse electrophotophoresis, in which the intensity of the movement depends on the magnitude and kind of the particle, and can be reversed by the electric field; and longitudinal electrophotophoresis. All the phenomena can be measured exactly and expressed numerically. H. H. Ho.

1922. Theory and Construction of the Circular Mass Spectrograph. H. Murawkin. *Ann. d. Physik,* 8. 2. *pp.* 203–260, *Feb.* 4, 1931.—The ordinary methods of detecting isotopes are restricted to investigating comparatively simple substances. To extend the field of investigation the author discusses methods of improving the line intensity and resolution of magnetic spectra of positive ions. Questions connected with the general theory, in particular the velocity distribution, are considered in detail. The various types of mass-spectrographs are briefly described and criticised. The conditions which must be fufilled by a more efficient type of instrument are set out. The apparatus resembles in principle that used by Ramsauer to measure the effective cross-section of molecules. Formulæ are worked out which give the maximum intensity of the spectral lines and the influence of the size of the slit on the intensity. The intensity is found to be directly proportional to the size of the slit and inversely proportional to the cube of the mean radius of the ionic paths. H. L. B.

1923. Vacuum Spectrograph for Precise Measurements of X-Rays of Long Wave-Length. C. E. Howe. *Rev. Sci. Instruments,* 1. *pp.* 749–757, *Dec.*, 1930.—The spectrograph has four unique features which make it fitted for precise measurements: (1) A slit system, consisting of five slits each 0·001 in. wide, excludes optical light and gives excellent collimation of the X-rays. (2) A universal grating support permits the plane grating to be set at any desired angle and to be removed *in vacuo* from the path of the X-rays without disturbing any adjustments. (3) A set of two parallel plate-holders at a fixed and known distance apart, placed at right angles to the slit system, permits accurate measurements of angles from the lines recorded on the two plates. (4) An X-ray tube with interchangeable targets is mounted on a micrometer slide permitting the focal spot to be readily lined up with the fixed slit system. The slit system, grating support and ways for the plate-holders are mounted as one unit which may be completely removed from the rest of the spectrographs for the purpose of adjustment. The apparatus is mounted on heavy concrete blocks to avoid mechanical vibrations. The spectrograph is maintained at constant temperature. Typical spectra are shown. AUTHOR.

1924. Double Crystal Spectrometer. J. W. M. DuMond and A. Hoyt. *Phys. Rev.* 36. *pp.* 1702–1720, *Dec.* 15, 1930.—A detailed description with method of working is given of a double crystal spectrometer designed for the study of X-ray spectra, with arrangement whereby one shaft simultaneously rotates the two crystals in equal and opposite directions, the spectrometer as a whole, and the X-ray tube at and in their respective proper rates and directions. [See also Abstracts 2217 and 2845 (1930).] C. A. S.

1925. X-Ray Apparatus for Investigation of Microscopic Crystals. Part II. O. Kratky. *Zeits. f. Krist.* 76. 3. *pp.* 261–276, *Dec.*, 1930.—The theory and practice of the method previously described [see Abstract 3157 (1930)] are given, with full details regarding the construction and use of the "stop" and the microcamera. The process is exemplified by the evaluation of photographs obtained from a crystal of potassium chlorate 0·025 mm. long and 0·012 mm. thick. C. A. S.

1926. Kathode-Ray Tube in X-Ray Spectroscopy and Quantitative Analysis. G. R. Fonda and G. B. Collins. *Am. Chem. Soc., J.* 53. *pp.* 113–125, *Jan.*, 1931.—The technique of a new method of exciting X-ray spectra for the purpose of quantitative analysis is described, in which electrons from a kathode-ray tube are allowed to strike the sample of material to be analysed. The spectra were registered and the intensity of the lines measured by using an ionisation chamber in conjunction with a vacuum tube amplifier. The photographic method was also used. Tests of the sensitivity of the method were carried out on a series of alloys in which it was found possible to detect 0·5 % of an element and estimate quantitatively 3 % or more. F. J. W.

1927. Passage of Light and X-Rays through Tubes. F. Jentzsch and E. Nähring. *Zeits. f. techn. Physik.* 12. 3. *pp.* 185–189, 1931.—In a previous paper [see Abstract 3078 (1929)] it has been shown that X-rays reflected from metals, after passing through air, have a refractive index nearly equal to 1. This fact is made use of when passing rays through a tube having glass or metal walls. For the critical angle, which is very small, the intensity of the rays emerging from the tube is considerably increased. The effect is compared with that of light passing down a glass tube containing a liquid of greater refractive index than the walls. In the case of X-rays, the apparatus consists of a source, the tube, an ionisation chamber, an electrometer and so forth. The opening into the chamber has the same radius as the tube. From the dimensions of the tube and the amount of ionisation occurring with and without the tube in position, the ratio of the rays reflected by the tube to the total intensity of the rays passing through can be calculated. This ratio can also be obtained theoretically from the energy equation of Kulenkamff given in 1922. The value depends upon the limiting angle of reflection and the wave-length of the reflected ray. The practical and theoretical values are shown to be in fair agreement. There is no abrupt discontinuity between total reflection and no reflection, but a gradual, rather rapid decrease in intensity. H. M. B.

1928. Effects of Kathode-Ray Diffusion on Intensities in X-Ray Spectra. D. L. Webster, H. Clark and W. W. Hansen. *Phys. Rev.* 37. *pp.* 115–135, *Jan.* 15, 1931.—The values of rediffusion constants and distribution functions needed for the calculation of effects on X-ray emission intensities are considered. A previous paper gave the intensity of the K lines from a very thin silver target supported on Be as a function of the voltage, in terms of the intensity at twice the excitation voltage. After correction for diffusion of kathode rays in the thin target and rediffusion from the Be, the corrected values differ from the originals by not more than 2 %. Sources of error are reviewed and pronounced negligible. Wave-mechanical theories involve approximations not valid at low voltages, but Bethe's theory agrees fairly well with these data. Empirically, the intensity $=$ const. $\times\, u^{-0\cdot 8} \log u$, where $u =$ (tube voltage/excitation voltage). For line intensities from thick targets the corrections for rediffusion are more than twice those for thin targets at all voltages considered and are of opposite sign. These calculations confirm suggestions by Kramers that most of the non-linear term in the intensity formula is due to rediffusion. W. V. M.

1929. Change of Wave-Length of X-Rays in an Absorbing Medium. J. M. Cork. *Comptes Rendus,* 192. *pp.* 153–155, *Jan.* 19, 1931.—Attempts to confirm the recent observations that a fraction of the radiation traversing an absorbing medium undergoes an increase in wave-length when observed in the direction of transmission are made with carbon and boron, but with negative results. C. B. A.

1930. Evidence for Electron Velocities as the Cause of Compton Line Breadth with the Multi-Crystal Spectrograph. J. W. M. DuMond and H. A. Kirkpatrick. *Phys. Rev.* 37. *pp.* 136–159, *Jan.* 15, 1931.—Experiments are described to test the correctness of the assumption that the initial velocities of electrons in the scattering body cause the observed breadth of the Compton shifted line. The natural breadth of the Compton lines for different scattering angles (63½°, 90°, 156°) and primary wave-lengths were observed and compared with theoretical values. The experiments were performed with a multi-crystal spectrograph of 50 units briefly described in the paper. Three spectrograms representing MoK radiation scattered from graphite together with microphotometer curves are given. The breadths observed are in agreement with the theoretical predictions, increasing with angle of scattering. The observed shifts agree with Compton's formula. The line breadths observed are greater than reported by Gingrich, Bearden and possibly Ross, but agree with Sharp and Nutting. The reason for the discrepancies is unknown. W. V. M.

1931. X-Ray Diffraction in Water: Nature of Molecular Association. G. W. Stewart. *Phys. Rev.* 37. *pp.* 9–16, *Jan.* 1, 1931.—The X-ray diffraction intensity-angle distribution for water and its variation for a temperature of 2° to 98° C. are given. Two important periodicities of 3·24 and 2·11 Å. and a third of 1·13 Å. at 21° C. are established in satisfactory agreement with Meyer. The first one *decreases* with increasing temperature and the second *increases*. It is shown that the conception of molecular complexes explains neither the existence of these periodicities nor their change with temperature. In fact, the description of "association" that involves complexes of two or three or more molecules should be abandoned in favour of the molecular group conception, (cybotactic condition) emphasised by the author. These groups of molecules containing hundreds and perhaps thousands of molecules in each have a temporary existence as individuals, have ill-defined boundaries, possess an optimum size and an internal regularity determined by the temperature and molecular forces, and expand anisotropically. The experimental facts are in agreement with this view. A detailed description of the molecular arrangement in water from X-ray data is not at present possible, yet it simulates the crystal arrangement in ice. A mathematical treatment of the forces within and between the molecules in such groups can probably be studied with much profit only from the quantum viewpoint. AUTHOR.

1932. Scattering of Short X-Rays by Molecular Hydrogen. H. S. W. Massey. *Cambridge Phil. Soc., Proc.* 27. *pp.* 77–85, *Jan.*, 1931.—Debye has shown that diffraction effects may be observed, due to the scattering of X-rays by gases, and that information as to the structure of molecules may be obtained in this way. He has introduced an approximate theory, but the molecules dealt with experimentally are so complex that it is, at present, impossible to proceed any further with their theoretical discussion. For hydrogen, however, the charge distribution in the ground state of the molecule is fairly well known, and the author considers this case. He starts from an equation of Waller, which gives the intensity of short radiation, at distance of R from a scattering charge distribution of density $W(x, y, z)$; and to find W makes use of the wave-function of the ground state of the molecule; and takes for ψ_1 the function obtained by Wang, using the Ritz method. The results are illustrated by graphs, one of which shows the ratio of the scattering of 0·5 Å. radiation by a hydrogen molecule to that due to two hydrogen atoms, plotted as a function of the angle of scattering. The graph has a wavy form, the ratio being alternatively positive and negative. It appears that the scattering, apart from the above oscillations, which could only be detected experimentally with the greatest difficulty, is very similar for molecular and for atomic hydrogen. H. N. A.

1933. Interference Measurements within the Molecule. L. Bewilogua. *Phys. Zeits.* 32. *pp.* 114–117, *Jan.* 15, 1931.—Debye's method [see Abstract 3741 (1930)] for interferentially measuring the distances within the molecule has been carried out first with X-rays and then with kathode rays. The present paper is devoted to a comparison of the two procedures, worked out mathematically and experimentally. The conclusion is reached that the X-ray procedure gives the more accurate results, though it is far more tedious than the other. A. D.

RADIOACTIVITY.

1934. Two Simple Methods of Purifying Radium Emanation. W. G. Moran. *Brit. J. of Radiology,* 3. *pp.* 555–560, *Dec.,* 1930.—A simple apparatus for the purification of radium emanation is described. The use of liquid air is avoided and the removal of water vapour found unnecessary. Two methods of purification are given. One method ignites the oxygen and hydrogen with a hot copper-oxide filament, which also oxidises excess hydrogen. The second method uses a spark to unite oxygen and hydrogen, while excess hydrogen passes through heated palladium to the outside air. The emanation may be withdrawn and collected over mercury at any stage in the purification. The concentration attained compares favourably with the results obtained with complicated installations. W. V. M.

1935. Distribution of Small Masses of Substance in Deposits Crystallising Out from Solutions. O. Hahn. *Preuss. Akad. Wiss. Berlin, Ber.* 30. *pp.* 547–555, 1930.—The practically weightless masses of easily observable radioactive atoms are a very suitable means of studying the behaviour of the smallest masses of substance in the most manifold processes. In this paper is considered the behaviour of such small masses, beneath their soluble product, on the crystallisation of salts from supersaturated solution. The behaviour of the radioactive substance serves as an indicator of the behaviour of the usual chemical elements similar to them, which for their part are not observable in small masses. With normal isomorphism the hitherto contradictory statements concerning the regularity of the distribution of radium in barium salts crystallising out from solution have found a satisfactory experimental explanation. Barium salts with logarithmic, or such with homogeneous distribution of radium can be obtained at will. In the cases in which an isomorphic capability of mixture of two salts has hitherto not been known macroscopically the differences in the kind of distribution of small masses of substance in greater crystal masses can be established in principle. The small masses in question can lead to an isodimorphic unitary structure or to an adsorptive accumulation. The two types can be clearly distinguished. The radioactive and photographic methods are an easy means of studying these processes. J. J. S.

1936. Theory of Atom Disintegration. G. Beck. *Zeits. f. Physik,* 67. 3–4. *pp.* 227–239, *Jan.* 21, 1931.—Continuation of a previous paper [see Abstract 533 (1931)]. The inelastic scattering by α-rays and the excitation of the nucleus are considered. The relative probabilities of the two possible processes, emission of γ-rays or H-particles, are calculated. The heavier nuclei are more especially considered. The probability that by a collision an α-particle in the nucleus is raised to a higher level is considerable as soon as the energy of the incident α-ray sensibly exceeds the excitation energy, and is of the order of magnitude 10^{-8} per 1 mm. air. The excited nucleus will if it contains H-particles emit H-rays of discrete energy. The limit of the capability of disintegration appears to lie very high. For lighter nuclei it is possible that α-rays are also emitted. This, however, can only occur in any marked degree if the excited nucleus contains no H-particles. If the energy of excitation for particle emission is not attained the excited nucleus passes over with emission of a γ quantum into the ground condition. J. J. S.

1937. Velocity of Disintegration of Polonium in Different Places. L. Bogoïavlensky. *J. de Physique et le Radium*, 2. *pp.* 12–19, *Jan.*, 1931.—A fresh series of determinations of the half-life period of polonium at various Russian towns has reduced the maximum variation from 125·6 – 181·6 to 134·0 – 142·8. The author still believes that there are genuine variations connected in some way with the geological structure of the locality, a connection he endeavours to bring out by several maps. [See also Abstract 1088 (1930).] C. A. S.

1938. Easily Absorbed Radiation Accompanying α-Rays of Polonium. Irène Curie and F. Joliot. *J. de Physique et le Radium*, 2. *pp.* 20–28, *Jan.*, 1931.—A connected account, with figures of apparatus, and curves of an investigation the results of which have already been published [see Abstract 3756 (1930)]. C. A. S.

1939. Use of a Thyratron with a Geiger Counter. N. A. de Bruyne and H. C. Webster. *Cambridge Phil. Soc., Proc.* 27. *pp.* 113–115, *Jan.*, 1931.—A thyratron, which is essentially a triode containing a small quantity of some inert gas, usually mercury vapour, has the property that for a certain critical voltage of the grid an arc strikes between the anode and the filament, with enormous increase in the anode current. The use of a thyratron for counting voltage impulses was first suggested by Hull [see Abstract 1953B (1929)]. The present method shows how voltage impulses produced in a Geiger counter may be amplified and applied to the grid of a thyratron. The voltage swing is of the order of 10 volts. The bias of the thyratron grid is so adjusted that this swing suffices to start the arc; the resulting anode current is used to move over the armature of an automatic counting machine. The time occupied in registering an impulse is considerably less than 0·1 sec. The advantages of the thyratron over mechanical relays are pointed out. [See also following Abstract.] H. L. B.

1940. Capture of Electrons by α-Particles. H. C. Webster. *Cambridge Phil. Soc., Proc.* 27. *pp.* 116–130, *Jan.*, 1931.—The general explanation of the capture of electrons by α-particles is that it occurs when the α-particle and electron move in the same direction with the same velocity. In experiments carried out by Davis and Barnes [see Abstract 2579 (1930)] it appeared that 90 % of the α-particles captured an electron in passing through an electron stream of approximately the same velocity. They also reported plentiful captures at other voltages. No other work on the attachment of electrons to ions has given evidence of an effect similar to that reported by Davis and Barnes. The general scheme of the present experiments is similar to that of Davis and Barnes, save that an electrical counter involving a thyratron [see preceding Abstract] is used instead of a scintillation screen. The experiments show that the upper limit of capture when the α-particles and electrons have the same velocity is 0·5 %. No evidence was obtained of capture at other velocities. There seems to be no possibility of reconciling the results of the present experiments with those of Davis and Barnes. H. L. B.

1941. Scattering of Slow α-Particles by Helium. P. M. S. Blackett and F. C. Champion. *Roy. Soc., Proc.* 130. *pp.* 380–388, *Jan.* 1, 1931.—Mott has shown, from consideration of the symmetry of the wave functions, that the scattering is quite different according to wave mechanics and the classical theory, when the scattering and scattered particles are identical. The present case is typical of the collision of identical particles, that have no spin, and obey the Einstein-Bose statistics. Mott's theory has been tested by Chadwick, using the scintillation method; but by using a Wilson chamber the scattering can be followed down to much lower velocities, where the maxima and minima predicted by Mott's theory are very marked. The authors have made photographs of about 50,000 α-rays from polonium, using an automatic Wilson chamber containing helium and oxygen, and measured the forks due to the collision of α-particles with helium atoms. The results obtained are in excellent agreement with Mott's theory. H. N. A.

1942. Rate of Loss of Energy by β-Particles in Passing Through Matter. E. J. Williams. *Roy. Soc., Proc.* 130. *pp.* 310–327, *Jan.* 1, 1931.—Discusses the subject theoretically from the points of view of the formulæ of Bohr and Gaunt. New observations have been made by the cloud method on the quantity taken as the range in Schonland's experiments. The results in oxygen for β-particles, with initial energy 19,590 volts, and those in argon with the same initial energy, are shown in curves. The results are practically free from the effects of scattering and straggling; these effects considerably reduce the quantitative value of most previous work on β-particles. The difference between theory and experiment is considerable; the rate of loss of energy is about 50 % greater than the theoretical for slow particles, and 80 % greater for fast particles in collisions for which the energy lost is less than 1500 volts. The discrepancies are almost as great if values are assumed for the dispersion frequency ν of the atomic electrons, which make the theoretical formulæ agree with the observed stopping power for α-particles. There is, however, a general agreement with theory in order of magnitude, and roughly in the way in which the phenomena vary with the velocity. [See also following Abstract.] H. N. A.

1943. Loss of Energy by β-Particles and its Distribution between Different Kinds of Collisions. E. J. Williams. *Roy. Soc., Proc.* 130. *pp.* 328–346, *Jan.* 1, 1931.—Records experimental results, which show that the quantum theory is in general agreement with experiment, and gives an explanation of several effects which were previously obscure, particularly in connection with primary ionisation. On the other hand the classical theory, while it is capable of giving some explanation of the total loss of energy, gives none whatever as to its distribution between the different kinds of collisions. This supports to some extent the assumption underlying Gaunt's calculations, that the laws which govern the perturbation of an atom by the electric force in a radiation field may be applied to the perturbation of an atom by the electric force of a moving charged particle, provided the reaction on the particle is small. Quantitatively the agreement between experiment and the results of the quantum theory is not, on the whole, very good. The theoretical rate of loss of energy and primary ionisation are greater than the observed values. In an added note attention is called to a recent theoretical paper by H. Bethe, using the quantum-mechanical theory of collisions developed by Born. The exact values of the stopping powers arrived at differ from those required by Gaunt's work, and they agree better with experiment. [See also preceding Abstract.] H. N. A.

1944. A γ-Radiation of Polonium. W. Bothe and H. Becker. *Zeits. f. Physik,* 66. 5–6. *pp.* 307–310, 1930.—A hard γ-radiation of high penetrating power from polonium was observed. The possibility of its origin through self-excitation of the decaying polonium nucleus is discussed. J. J. S.

1945. Photographic Effects of γ-Rays. J. S. Rogers. *Phys. Soc., Proc.* 43. *pp.* 59–67, *Jan.,* 1931.—The photographic action of γ-rays from radium and radon in equilibrium with their short-lived products has been investigated, the rays being filtered with lead screens of thicknesses 0, 0·19, 1·42, 2·61 and 4·03 cm. The variations of photographic density both with time and with intensity has been examined. The shape of the characteristic (C) curves (D — log I) have been found to be independent of the filtering, and the same holds for the Hurter-Driffield (H.D.) curves (D — log t), except when no lead filter is used. The value of p in the Schwarzschild relation, $D = f(It^p)$, has been found to be unity for all the lead filters. The absorption coefficient of lead for γ-rays from the sources used has been found to be 0·533 cm.$^{-1}$ for thicknesses of lead from 1 to 7 cm. AUTHOR.

1946. Photoelectric Absorption of γ-Rays. L. H. Gray. *Cambridge Phil. Soc., Proc.* 27. *pp.* 103–112, *Jan.,* 1931.—Combining Ellis and Aston's empirical law [see Abstract 537 (1931)] for the connection between the photoelectric absorption (τ) and the wave-length (λ) of the γ- or X-rays absorbed with a critical consideration of all experimental results available, the relation $\log_{10}\tau = \bar{3}\cdot605 + \log_{10}\lambda + 0\cdot480\,(\log_{10}\lambda)^2$ is deduced. [See also Abstracts 536 (192[illegible]) and 1908, 3763 (1930).] C. A. S.

1947. Atmospheric Ionisation by Cosmic Radiation. E. O. Hulburt. *Phys. Rev.* 37. *pp.* 1–8, *Jan.* 1, 1931.—From Millikan's measurements of the intensity and the absorption coefficients of cosmic radiation the ionisation in the atmosphere is calculated from sea level to 60 km. The electron density is negligibly small in this region. The ion density increases with the height to $3\cdot5 \times 10^3$ ion pairs cm.$^{-3}$ at about 50 km. and is roughly constant above this to 60 or 70 km. where the solar ultraviolet light ionisation sets in. The 50 km. ion bank refracts appreciably radio waves longer than 12 km. and being unchanged with the day and night accounts for the propagation of waves longer than 12 km., which are known to show no marked diurnal variations. The agreement with the facts of long radio waves indicates that there exists in the high atmosphere but little cosmic radiation of less penetration than Millikan has already detected. By considering the effect of the earth's magnetic field on high speed electrons the " run-away " electron hypothesis of C. T. R. Wilson to account for cosmic radiation is shown to lead to a distribution most intense at low latitudes and feeble at high latitudes, thereby being in disagreement with Millikan's observation of the constancy of the cosmic radiation with latitude. AUTHOR.

1948. Cosmic Electron Rays and the Earth. E. Brüche. *Phys. Zeits.* 32. *pp.* 31–33, *Jan.* 1, 1931.—A short discussion as to whether the penetrating cosmic radiation may be explained as electron radiation from space, and on the distribution of direction of the arriving radiation. It is concluded that only rays whose velocity is very little under the velocity of light can reach the mean latitudes of the earth. J. J. S.

HEAT.

1949. Test of the Christiansen Thermal Conductivity Apparatus for Gases. H. Dierkes. *Phys. Zeits.* 32. *pp.* 84–91, *Jan.* 15, 1931.—The thermal conductivity apparatus devised by Christiansen, using three plates, of which two are maintained at constant temperatures, has been extensively studied with a view to its use for measuring the thermal conductivities of gases. It is concluded that the difficulties due to convection and other causes cannot be entirely overcome with this type of apparatus. J. H. A.

1950. Absorptive Power of Blacks and Whites for Particular Wave-Lengths. E. Hasché. *Ann. d. Physik*, 8. 1. *pp.* 47–88, *Jan.* 26, 1931.—Two methods are described for the measurement of the reflectivity or absorption respectively of diffuse reflecting materials in the region from 0·36 μ to about 8 μ. The absorptive power of particular materials, especially those which, in building, etc., find a use for ornamentation purposes, is investigated and an attempt made to find a relationship between absorption and wave-length. The theory of the Ångström pyranometer is fully discussed in this connection, and at the same time it is shown that a correspondence between the Ångström pyrgeometer and the pyranometer is possible. The paper concludes with a definition and discussion of the "absolute" thermopile which is evolved for further work, as a consequence of the results obtained in the present paper. S. G. B.

1951. Experimental Survey of Radiometer Questions. E. Brüche and W. Littwin. *Zeits. f. Physik.* 67. 5–6. *pp.* 333–361, *Jan.* 31, 1931.—An extension of previous work [see Abstract 1606 (1929)] on the single plate radiometer, in the light of further experimental and other developments. The use of different gases, the distance from the walls of the plate, the nature of the vane, etc., are discussed and a simple general equation to the radiometer curve is deduced. In the instrument used the vane hangs between and parallel to a cold and a hot wall. By means of a magnetic torsion device the vane is set in its proper place at right angles to the heat stream. The effects of warming the cold wall and the total radiometer force were determined for constant temperature superiority of the heated foil. The radiometer effect is throughout the entire investigation found to be proportional to the excess temperature of the hot face of the vane. For small pressures the radiometer effect is, in accordance with previous knowledge, proportional to the pressure. Good agreement with the work of Knudsen was found. An exception therefrom occurred in the case of light gases such as hydrogen and helium. In accordance with earlier work, for great pressures, the radiometer effect is inversely proportional to the pressure. The exact determination of the curve for high pressures gave agreement with the work of Schmudde, showing known digressions from the hyperbola. For small pressures the gas effect is not effective. For high pressures, in agreement with theory, the effect is proportional to the square of the free wave-length of the gas under discussion. The conditions for maximum radiometer effect are prescribed. The influence of the enclosing walls and the form of the vane are discussed. The increment of the vane edges by means of a grating design gives, for high pressures, a considerable increase in the effect. From the results obtained the radiometer equation is found to be of the form $2R_m/R = \lambda/\lambda_m + \lambda_m/\lambda$, where R = radiometer force for a pressure p, R_m = radiometer force at the maximum, λ = free wave-length at pressure p, λ_m = free wave-length at the maximum. S. G. B.

1952. Heat Transmission Problem. E. Brüche and W. Littwin. *Zeits. f. Physik*, **67.** 5–6. *pp.* 362–374, *Jan.* 31, 1931.—The resistance and temperature of a platinum foil heated by a constant stream of heat radiation were examined in 13 gases at pressures between 10^{-5} mm. and 1 mm. of Hg. The apparatus used is similar in principle to that of Schleiermacher and is fully described. In the range of pressures taken the temperature can be exactly determined and expressed by means of a three or four constant formula. These constants lead to three conditions being postulated and further correspond to three important attributes, namely: Radiation and heat conductivity of the holders, the heat conductivity at high pressures and the free wave-length of the gas. It is shown that krypton exhibits an extremely small heat conductivity which is less than the least known gas heat conductivity, the value at 0° C. being $\sim 1 \cdot 9 \times 10^{-5}$. Xenon probably has a yet smaller value. The shape and form of the usual curves are discussed, and the results closely linked up with previous work [see preceding Abstract]. S. G. B.

1953. Heat Transmission of Fluids in Tubes. M. ten Bosch. *Phys. Zeits.* **32.** *pp.* 39–43, *Jan.* 1, 1931.—A criticism of a paper by Schiller and Burbach [see Abstract 2773 (1928)] for the measurement of heat transmission in tubes containing flowing liquids. The author attempts to show that there are serious discrepancies in their work, in that to the small bore of the experimental tube is ascribed any influence on the heat transmission in contrast to the findings of other workers. Attached is a *Reply* by **L. Schiller** and **T. Burbach** which deals seriatim with the various points raised by ten Bosch and defends their contention. S. G. B.

1954. Transmission of Heat in a Fluid in Turbulent Motion. J. Caldwell. *Roy. Techn. Coll. Glasgow, J.* **2.** *pp.* 409–415, *Jan.*, 1931.—It is shown that the Reynolds theory of heat transmission, correct in its basic idea of associating the transmission of heat and momentum in turbulently flowing fluids, is not correct when applied to pipe flow. A refinement of the ideas in the Reynolds theory is made and a new quantity "the coefficient of heat conductivity in turbulent flow" is introduced. It is then shown that, for any case of turbulent flow in which "the coefficient of molar viscosity" is known, this coefficient of heat conductivity for turbulent flow is immediately calculable. AUTHOR.

1955. Temperature Distribution in a Finite Cylinder during Heating or Cooling. F. Berger. *Zeits. f. angew. Math. u. Mechanik*, **11.** *pp.* 45–58, *Feb.*, 1931.—This problem is solved mathematically, with notes on the performance of the numerical calculations in any particular case. J. H. A.

1956. Differential Ebullioscope with Fractionator. W. Swietoslawski. *Acad. Polonaise Sci. et Lettres, Bull.* 9–10. *A. pp.* 504–517, *Nov.–Dec.*, 1930.—The apparatus is intended to measure the difference between the temperature of ebullition and the temperature of condensation of a liquid, whether a simple compound or a constant-boiling mixture. Examples of results obtained with it are given, and modifications are also described which use only about 20 gm. and only 5 or 6 respectively. Methods of filling the apparatus receive particular attention, and its value in studying the purity of a liquid is emphasised and illustrated with examples. J. H. A.

1957. Compensated Thermopile for Measurements of Total Radiation. J. Guild. *Journ. Sci. Instruments*, 8. *pp.* 14–17, *Jan.*, 1931. —The paper describes an instrument in which two similar thermopiles are mounted close together and connected in opposition so as to neutralise the effects of air currents in their neighbourhood. The radiation is received by one of the piles only, a system of diaphragms being fitted which prevents it from reaching the other, although both are equally accessible to air currents. The advantage of the instrument is that it can be used without a window, thereby avoiding difficulties from selective absorption when evaluating total radiation. AUTHOR.

1958. Melting Point of Platinum. G. Ribaud and P. Mohr. *Comptes Rendus*, 192. *pp.* 37–38, *Jan.* 5, 1931.—A tube of platinum was brought to the fusion point by passing a current through it, and its temperature was measured by means of an optical pyrometer, with which the interior of the tube was viewed through a small hole, as in the previous measurements made on palladium (black body method). The method of optical extrapolation employed is described. The temperature of fusion of platinum was found to be 1762° C. The uncertainty is not more than 2° C. H. N. A.

1959. Freezing of Dilute Undisturbed Solutions. V. Giambalvo. *Zeits. f. techn. Physik*, 12. 2. *pp.* 111–113, 1931.—A short general discussion of the problem. J. H. A.

1960. Specific Heats of Thallium, Calcium and Magnesium Down to 10° K. Entropy of Magnesium. K. Clusius and J. V. Vaughen. *Am. Chem. Soc.*, *J.* 52. *pp.* 4686–4699, *Dec.*, 1930.—The specific heats are measured between 10° K. and 250° K., using specially pure samples in a vacuum calorimeter. The results for calcium are accurate to 1·5 % at 10° K. and 0·3 % at 80° K., the errors being slightly less for thallium and slightly greater for magnesium. The constant A in the equation, $C_p - C_v = AC_p^2T$ has the values: $A_{Tl} = 2\cdot85 \times 10^{-5}$, $A_{Ca} = 2\cdot4 \times 10^{-5}$, $A_{Mg} = 2\cdot61 \times 10^{-5}$. Debye's characteristic temperature Θ is found to be: $\Theta_{Tl} = 94°$ above 17° K., $\Theta_{Ca} = 233°$ above 65° K., and $\Theta_{Mg} = 322°$ above 30° K. The behaviour of magnesium is anomalous in that Debye's Θ increases below 30° K., implying a failure of the T^3-law for which no explanation is apparent (compare behaviour of Cu and W). The calculated entropies at the absolute zero are: $S_{Tl} = 15\cdot51$, $S_{Ca} = 9\cdot72$, and $S_{Mg} = 7\cdot76$. The entropy of Mg at 25° C. is 35·51 (calculated) against 35·29 (empirical), while its vapour pressure constant is found to be $0\cdot443 \pm 0\cdot1$ log. atmospheres on classical thermodynamical considerations or 0·493 on statistical grounds. L. V. C.

1961. Specific Heat of Osmium and Rhodium between 0° and 1625° C. Part IV. F. M. Jaeger and E. Rosenbohm. *K. Akad. Amsterdam, Proc.* 33. 1. *pp.* 85–99, 1931.—The experimental method has been given previously [see Abstract 3774 (1930)]. For osmium, C_p is a linear function of temperature, whilst for rhodium the equation must include powers up to the fourth. In the case of the latter metal, the specific heat curve passes through a maximum, and work is described on the electrical and thermoelectric properties, in attempting to elucidate the cause of this. J. H. A.

1962. Graphical Treatment of the Thermodynamics of the Rectifying Column. W. H. Keesom. *K. Akad. Amsterdam, Proc.* 33. 9. *pp.* 901–908, 1930. *Suppt. No.* 69*a*. from the *Phys. Lab. Leiden.*—A graphical solution is given for binary mixtures, taking into account the compositions and quantities of the products, the compositions of the different mixtures upon and between the plates of the rectifying column, the quantities which per unit of time flow in upward or downward direction, and the energy consumed by the separation process in the column. The simplifying assumptions made include: No heat exchange between different parts of the apparatus or the substances contained therein, or between a liquid flowing down and a rising vapour. Pressure differences in the apparatus are neglected, the phases being considered homogeneous everywhere and uniform in temperature. H. H. Ho.

1963. Calculations of Distillation Equilibria. G. Bozza. *Accad. Lincei, Atti,* 12. *pp.* 675–681, *Dec.* 21, 1930.—Gives an improved method for determining the composition of the vapour in equilibrium with a given binary or ternary mixture, from measurements of the various liquid fractions. J. H. A.

1964. New Method for Measuring Extremely Low Vapour Pressures. H. Mayer. *Zeits. f. Physik.* 67. 3–4. *pp.* 240–263, *Jan.* 21, 1930.—The essence of the method lies in having two connecting vessels, in one of which the pressure is that of the vapour to be measured, and in the other is a pressure several hundred times less than that of the vapour, so that the difference in pressure is equal to the vapour pressure itself. A tube connects these two vessels, and in front of its opening is a light vane, which is deflected by an amount proportional to the pressure difference. Tests on this manometer are given in detail, with an account of the theory of its action. The deflection is practically independent of temperature and of the nature of the molecules striking the vane. It is considered suitable for pressures from 10^{-7} to 10^{-2} mm. of mercury. Measurements of the vapour pressure of mercury from − 12° to 25° C. are given, with different capillaries, giving sensitivities from 1 to 13×10^{-6} mm. pressure per mm. deflection of the vane. The results are compared with those of Smith and Menzies and of Knudsen. Observations are also given for the vapour pressure of potassium, from 60° to 140° C. They are represented by the formulæ $\log p = 7{\cdot}403 - 4448{\cdot}7/T$ or $T \log p = 10{\cdot}418 - 21087/4{\cdot}571\,T$, where p is the pressure in mm. and T is the absolute temperature. Extrapolated to the boiling point (1030° K.) the second formula is only 11 % high. The results are compared with those of Killian, of Edmondson and Egerton and of Weiler.
J. H. A.

1965. Vapour Pressure of Ramsay Grease. H. Mayer. *Zeits. f. Physik,* 67. 3–4. *pp.* 264–269, *Jan.* 21, 1931.—The vapour pressure of Ramsay grease (the rubber compound used in making joints for vacuum work) has been measured by the author's method [see preceding Abstract]. It does not give reproducible values unless maintained previously for several hours at a temperature above its melting point, about 36° to 42° C. The steady value is about $1 \cdot 1 \times 10^{-5}$ mm. at 13° C. J. H. A.

1966. Vapour Pressure and Activity of a Liquid Component in Binary Alloys at High Temperatures. K. Jellinek and G. A. Rosner. *Zeits. f. phys. Chem.* 152. *Abt. A.* 1–2. *pp.* 67–94, *Jan.*, 1931.—The vapour pressure of cadmium in lead-cadmium, tin-cadmium and copper-cadmium alloys has been measured over the temperature range of 500°–700° C., and in concentrations extending from 10 to 60 mol. % of cadmium. Further, the vapour pressure of zinc in copper-zinc alloys has been determined over the same range of concentrations and at temperatures between 600° and 800° C. The activity coefficients, latent heat of vaporisation and heat of mixing of cadmium and zinc in these alloys have been calculated. F. J. W.

1967. Properties of Saturated Vapours, including Steam. A. Press. *Phil. Mag.* 11. *pp.* 111–118, *Jan.*, 1931.—Two equations are obtained from the first law of thermodynamics, which lead respectively to justifications of Callendar's equation of state, and of Nernst's theorem. It appears further that the adiabatic index for steam is 1·11, as against Zeuner's value of 1·135 and Perry's of 1·14. J. H. A.

1968. Adiabatic Temperature Change of Water under Pressure. K. J. Umpfenbach. *Zeits. f. techn. Physik*, 12. 1. *pp.* 25–29, 1931.—The temperature change in water, due to a pressure applied adiabatically, may be calculated as $(T/C_p)(dv/dT)_p$, where T is the absolute temperature, C_p the constant pressure specific heat in mechanical units and $(dv/dT)_p$ is the coefficient of cubic expansion under constant pressure. This temperature change has been directly measured by a number of observers, and there is a general discrepancy between the experimental and theoretical values, due possibly in part to the difficulty of obtaining adiabatic conditions. The most probable values are discussed, and it is further pointed out that the quantity in question may also be obtained from throttling experiments on the fluid, which give $(dT/dp)_i = (dT/dp)_s - v/C_p$, where v is the specific volume, and $(dT/dp)_i$ represents the condition of constant total heat. Some experiments carried out in this way support the " theoretical " values for $(dT/dp)_s$. J. H. A.

1969. Waves of Thermal Agitation, and Internal Pressure in Liquids. T. Takéuchi. *Phys. Math. Soc., Japan, Proc.* 13. *pp.* 17–18, *Jan.*, 1931. *In French.*—L. Brillouin's conception of waves of thermal agitation in a liquid is developed to account for a reduction of internal pressure with increase of temperature. The rate of transference of momentum across unit area in the liquid is shown to be equal to one-third of the density of thermal energy. A new interpretation of van der Waals' equation is suggested. J. P. A.

1970. Method for Determining Critical Temperatures. Critical Temperature of Hydrogen Fluoride. P. A. Bond and Della A. Williams. *Am. Chem. Soc., J.* 53. *pp.* 34–37, *Jan.*, 1931.—The method used is one which avoids the necessity for seeing any meniscus, so that a metal tube, rather than a glass one, may be used. The principle of the method is to heat a sealed tube, originally half filled with liquid, above the critical temperature; the tube is suspended from a balance arm, and hangs at an angle of about 20°. Thus as it cools down liquid begins to

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form when the critical temperature is reached, and this runs to the lower end, so disturbing the balance. The temperature is then noted. The method was checked with SO_2. The value found for HF was 230·2° C., and this gives a value $T_c/T_b = 1{\cdot}72$, where T_c, T_b, are the critical and boiling points on the absolute scale. This is close to the value for the other halogen acids. J. H. A.

1971. Direct Connection between the Equation of State and Viscosity. L. Schames. *Phys. Zeits.* 32. *pp.* 16–20, *Jan.* 1, 1931.—As in a previous paper [see Abstract 1655 (1928)], the potential function for a molecule is taken as $B/r^n - A/r^m$, where r is the distance from the centre. From this, the variation of effective diameter with temperature is calculable, and then, assuming the gas-kinetic collisions take place between elastic spheres of this diameter, two consequences follow. Both the viscosity and the coefficient b in van der Waals' equation may be evaluated as functions of temperature. Using the "reduced" values, b is plotted against the reciprocal of temperature. In certain cases, the resulting curves are straight in the region of ordinary temperatures, and this leads to a viscosity equation differing somewhat from that of Sutherland. Finally, the virial coefficients are tabulated as functions of temperature for a number of gases. These virial coefficients are the coefficients B and C in the equations $pv = A + B_1 p + C_1 p^2 + \ldots$ and $pv = (pv)_0\left(1 + \frac{B_2}{v} + \frac{C_2}{v^2} + \ldots\right)$. J. H. A.

1972. Calculation of Free Energy from Spectroscopic Data. W. F. Giauque. *Am. Chem. Soc., J.* 52. *pp.* 4808–4815, *Dec.*, 1930.—The exact calculation of free energy and other properties of the standard thermodynamic state of gases are discussed, and the methods and equations necessary for the calculations described. A simple method of deriving a general expression for the absolute entropy of ideal gases is given. Molecular rotation, vibration, electronic excitation and nuclear spin are taken into account in developing the calculation, and the method indicates the relationship between complicated molecular states and the entropy. The equations are shown to be capable of use as a basis for an extended tabulation of free energy of gases deduced from available spectroscopic data. F. J. B.

1973. Entropy of Hydrogen and the Third Law of Thermodynamics. Free Energy and Dissociation of Hydrogen. W. F. Giauque. *Am. Chem. Soc., J.* 52. *pp.* 4816–4831, *Dec.*, 1930.—Several thermodynamic properties of the hydrogen molecule are calculated from band spectrum data. The equilibrium composition of hydrogen is calculated, and the relative amounts of ortho- and para-hydrogen molecules at equilibrium are calculated over a large range of temperatures, up to 5000° Abs. Tables of free energy functions for hydrogen are given for temperatures up to 5000° Abs. The absolute entropy of hydrogen is found to be 33·98 cal./deg./mol. The accuracy of this figure for the absolute entropy of hydrogen is considered to be such that no reasonable doubt exists of its value. F. J. B.

1974. Chemical Constant of Hydrogen Vapour and the Entropy of Crystalline Hydrogen. T. E. Stern. *Roy. Soc., Proc.* 130. *pp.* 367–379, *Jan.* 1, 1931.—Fowler has obtained fairly accurate results for the chemical constant by means of classical statistics; but the author shows that, by using the Einstein-Bose statistics—the correct statistics for an assembly of hydrogen molecules—a result can be obtained for the vapour pressure of hydrogen crystals at low temperatures, which furnishes a value for the chemical constant in even closer agreement with experiment than Fowler's value. It is also shown that the theory implies the existence of slight variations in the composition of the mixed crystals of ortho- and para-hydrogen, when they are allowed to form from the gas at low temperatures. Follows the vapour pressure equation from low temperatures to ordinary temperatures, and shows how a term $\frac{3}{4}$ log 3 appears in the chemical constant, when its value is calculated at ordinary temperatures. The chemical constant at low temperatures is found to be $-1{\cdot}11$, which agrees well with Eucken's experimental value, $-1{\cdot}09 \pm 0{\cdot}02$. At ordinary temperatures the theory gives $-3{\cdot}70$, and Eucken's value is $-3{\cdot}68 \pm 0{\cdot}03$. Derives by means of statistical mechanics expressions for the entropy of different sorts of hydrogen crystals (para-hydrogen and ordinary hydrogen) at the absolute zero, which are in complete agreement with the results of MacGillavry, but are obtained in a simpler manner.

H. N. A.

1975. Calculation of van der Waals' Forces for Hydrogen and Helium at Large Interatomic Distances. H. R. Hassé. *Cambridge Phil. Soc., Proc.* 27. *pp.* 66–72, *Jan.*, 1931.—The paper is based on the method used by the author [see Abstract 730 (1931)] in calculating the polarisability of helium. Hydrogen is investigated in some detail, in order to explain the method of approximation used in this application of the principle of minimum energy. It is shown that the successive approximations assumed for ψ, the disturbed wave-function, converge very rapidly, the first approximation for the energy being $-12R^{-6}$, where R is the distance between the nuclei, the second $-12{\cdot}9375R^{-6}$, the third $-12{\cdot}9798R^{-6}$ and the fourth $-12{\cdot}9951R^{-6}$. In the application to this particular problem the results correspond very closely to those obtained by Lennard-Jones, using the modified perturbation theory. Deals with the van der Waals' force for helium, and finds that the result of the calculation is that the interatomic force at large distances lies between $7{\cdot}91 \times 10^{-60}R^{-7}$ and $8{\cdot}21 \times 10^{-60}R^{-7}$. In an addendum it is shown, however, that a determination of ψ_0, the undisturbed potential for the helium atom, may be unsuitable for use as the basis of further investigations, in spite of the fact that it gives a very accurate result for the energy of the atom itself.

H. N. A.

1976. Diffusion Considered as a Pulsation Process. W. Jazyna (Jacyno). *Zeits. f. Physik*, 67. 3–4. *pp.* 278–288, *Jan.* 21, 1931.—The author discusses the process of gaseous diffusion from the respective points of view of the following postulates: (1) that the thermodynamic condition of perfectly insulated bodies is independent of locality, *i.e.*, is not changed by translation in a field free from gravitation, and (2) that matter is impenetrable, *i.e.*, the same space cannot be occupied by more than one portion of matter at one and the same time. It is shown that the change of entropy accompanying the inter-diffusion of Clapeyron systems can be derived from the application of these postulates, and that in the case of the diffusion of *real* gases there occurs an actual change of entropy.

J. S. G. T.

SOUND.

1977. Acoustical Characteristics of Singly-Resonant Hot-Wire Microphones. E. T. Paris. *Phys. Soc., Proc.* 43. *pp.* 72–84; *Disc.,* 84–86, *Jan.,* 1931.—A method is described for measuring the damping-coefficients and conductances of the orifices of the small resonators used in the construction of hot-wire microphones. Observations show that resonant microphones with cylindrical necks of diameter between 0·5 and 0·64 cm. and length between 1·2 and 2·25 cm. have damping-coefficients which are about 23 % greater than the values indicated by theory. The observed conductances of the necks agree very closely with those calculated from a formula in which allowance is made for the added inertia due to viscosity. [See also Abstract 3162 (1927).] AUTHOR.

1978. Measurement of Sound Intensity by Acoustic Flicker Methods. F. Canac. *J. de Physique et le Radium,* 2. *pp.* 42–60, *Feb.,* 1931.—A telephone receiver is supplied with current of musical frequency from a valve circuit. The receiver is shunted alternately by unequal resistances about ten times per sec. by means of a special commutator, and the sounds heard differ in intensity. The variation in intensity $\Delta I/I$ is shown to be related to the variation in resistance of the shunt $\Delta R/R$. If ΔI is great, the ear hears a flickering or beating sound; if ΔI is sufficiently weak, a continuous sound is heard. Circuits are given by means of which the minimum perceptible variation of intensity is obtained, the necessary conditions being continuous change of the sound without sudden change of phase, intervening silences or accompanying noises. The ratio $\Delta I/I$ is nearly constant and amounts to several hundredths. It increases as the intensity diminishes, and it is nearly independent of the frequency. When comparison is made with a standard sound, equality is obtained over a certain range of intensities. Taking the middle of this range as corresponding to the standard intensity, the measurement may be made to about 1 in 100. G. E. A.

1979. Acoustical Investigations of Musical Instruments. Part II. The Syamisen, a Three-Stringed Instrument. J. Obata and Y. Ozawa. *Phys. Math. Soc., Japan, Proc.* 13. *pp.* 1–16, *Jan.,* 1931. *In English.*—The syamisen, shamisen or samisen, the most important and popular Japanese stringed instrument, has a small body with a long neck and fingerboard. The nearly square body is formed of a wooden frame the front and back of which are covered with animal skin. The fan-shaped plectrum strikes the string and also the body below. The active length of the silk strings is about 80 cms. and they are normally tuned to the notes B, E, B of the bass clef with respective frequencies about 133, 177 and 266. The syamisen is usually employed as an accompaniment to singing, or by itself, or along with the syakuhati and koto. A number of syamisens were tested as played by two virtuosi, and wave records and sound spectra were obtained as before [see Abstract 1606 (1931)]. The records show that a very weak sound of high pitch is first produced by the plectrum on striking the string. This is followed by a trail of irregular waves caused by the plectrum striking the body, and then by a series of regular waves due to the free vibration of the string and resonance of the body. The results give the relative intensities of the partials up to the twelfth, and include the special modes of sounding the strings known as *hadiki* and *sukui*. G. E. A.

1980. Fingering of Conical Wind Instruments. E. J. Irons. *Phil. Mag.* 11. *pp.* 535–539, *Feb.*, 1931. *Supplement.*—In a former paper [see Abstract 4068 (1930)] formulæ for the acoustical impedance of various units were derived. In a second paper they were applied to problems concerning the fingering of wind instruments of cylindrical form. In this note the argument is extended to include instruments of conical shape. G. E. A.

1981. Phase Difference and Amplitude Ratio at the Ears Due to a Source of Pure Tone. F. A. Firestone. *Acoustical Soc. America, J.* 2. *pp.* 260–270, *Oct.*, 1930.—Measurements of the phase difference and amplitude ratio of the sound entering the ears of a man-shaped wax dummy were taken with the source at various azimuths around the head at a number of frequencies and distances. The measurements at 256 and 1024 ∼ per sec. agree with calculations of Hartley and Fry [see Abstract 1346 (1922)] based on the assumption that the head is a rigid sphere in free space, except that the values of amplitude ratio are about 13 % less than the calculated figures on account of the interference of the neck. The values at 1944 ∼ per sec. are quite different from the computed values. [See also following Abstract.] L. E. C. H.

1982. Binaural Localisation of Pure Tones. E. R. Wightman and F. A. Firestone. *Acoustical Soc. of America, J.* 2. *pp.* 271–280, *Oct.*, 1930.—Pure tones of frequency 256 ∼ per sec. were presented binaurally to eight different observers, the phase difference and amplitude ratio of the acoustical pressures at the two ears being known and adjustable. The observers were asked to state the direction and distance of the apparent source of sound. Only three of the eight observers were influenced in their judgment of direction by the phase difference and even they were rather inaccurate. All were influenced more or less in judging direction, by the amplitude ratio. None was able to tell the distance of the source by the amplitude ratio. [See also preceding Abstract.]

AUTHORS.

1983. Problems Suggested by an Uncertainty Principle in Acoustics. G. W. Stewart. *Acoustical Soc. of America, J.* 2, *pp.* 325–329, *Jan.*, 1931.—An uncertainty principle in acoustics, arising wholly from classical views, is presented. This principle is that $\Delta\nu \cdot \Delta t \sim 1$, where ν is the intrinsic frequency of an acoustic signal and Δt is its time duration. Applying this principle one finds that it is consistent with experiments on the change in frequency in the vibrato and the failure to detect it by ear, with recorded tests on minimum perceptible differences in frequency, and with the minimal time for tone perception. The problems suggested by the principle are: (1) variations in Δt and $\Delta\nu$ by an artificial vibrato with aural observations of detectable $\Delta\nu$, (2) redetermination of minimum perceptible differences in frequency as dependent upon Δt and (3) an examination of Δt required for tone perception with varied values of $\Delta\nu$. AUTHOR.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

1984. Calculation of the Resultant and of the Resultant Moment of the Electrostatic Pressures in a Plane Field. A. Masotti. *Accad. Lincei, Atti,* 12. *pp.* 439–444, *Nov.* 2, 1930.—Calculations are given based on the analogy between the electrostatic pressures which are exercised on the surface of an electrified conductor in equilibrium and the hydrodynamic pressures that a liquid in permanent and irrotational motion exerts on the surface of an immersed solid. Hence are deduced formulæ for the calculation of the resultant and of the resultant moment of the electrostatic pressures in plane fields which are analogous to the hydrodynamical formulæ of Blasius. Reference is made to the electrostatic interpretation given by Signorini of the theorem of Kutta and Joukowski and likewise the electrostatic interpretation of Grammel's theorem. Thus the following proposition may be enunciated: An indefinite cylindrical conductor is placed in an electric field that has uniform distribution to infinity. The resultant of the electrostatic pressure on unit of length of the conductor has the direction and sense of the electric force at infinity and has for value the product of the intensity of this into the charge of unit length of the conductor. The system of the electrostatic pressures is equivalent to the above-mentioned resultant applied in the baricentre of the charges.
J. J. S.

1985. Electric Condenser Consisting of a Straight Wire between Two Parallel Planes. A. Masotti. *Accad. Lincei, Atti,* 12. *pp.* 519–522, *Nov.* 16, 1930.—The problem is taken as a two-dimensional one, by assuming the wire and planes to be infinitely long, and the value of the capacity is then found to be $k/2 \log\left(\frac{2a}{\pi r}\cos\frac{\pi d}{a}\right)$, where k is the dielectric constant of the medium, a the distance apart of the planes, r the small radius of the wire and d the distance of the wire from a reference plane midway between the two planes which form part of the condenser. The force experienced by the wire is always directed towards the nearer plane, and an expression for its value is given. J. H. A.

1986. New Method of Measuring the Capacity of Small Condensers. H. M. Barlow. *Phil. Mag.* 11. *pp.* 184–193, *Jan.,* 1931.—The method described consists in the use of an alternating potential to charge the condenser periodically in opposite directions through ordinary rectifying valves, each being provided with a neutralising battery to compensate the electron energy from the hot filaments. The peak value of the applied potential is found by interrupting the current through one valve and balancing the p.d. across the condenser against that of a battery, across which a system of resistances forms a potential divider. A simple calculation then gives the capacity of the condenser in terms of the resistances and the supply frequency. For the latter a valve-controlled tuning-fork oscillator was used with a frequency of 800 p.p.s. In some cases it is found desirable to flatten the wave crests in the supply and this may conveniently be effected by means of another pair of rectifying valves used in a manner similar to that described by Rogowski and Glage [see Abstract 141 (1921)]. Applications and limitations of the method are briefly discussed. A. W.

1987. Ballo-Electric Phenomena and the Potential Difference at the Surface of Separation between Gas and Solution. A. Frumkin and A. Obrutschewa. *Kolloid Zeits.* 54. *pp.* 2–7. *Jan.*, 1931.—The spraying of liquids leads to a separation of opposite electric charges, a phenomenon named water-dropping or bubble electricity and, by Christiansen, ballo-electricity. The present authors do not wish to develop a complete theory of ballo-electricity, but wish merely to investigate and consider solutions containing, side by side, capillary inactive electrolytes and capillary active non-electrolytes. It is deduced with few exceptions that the ballo-electrical capacity of different molecules is dependent on the type of their orientation at the surface of separation. The different compounds can be divided into two classes (the hyperkataballic and hyperanaballic bodies of Christiansen) depending on whether the positive end of the molecule in the surface of separation is directed towards the gas phase or towards the liquid phase. Water must be considered as belonging to the second class. J. K.

1988. Intramolecular Field and the Dielectric Constant. F. G. Keyes and J. G. Kirkwood. *Phys. Rev.* 37. *pp.* 202–215, *Jan.* 15, 1931.—A statistical calculation of the average internal field in a dielectric is carried out. The following relation is obtained between the dielectric constant, ϵ, and the molecular polarisability, p_0:

$$\frac{\epsilon-1}{\epsilon+2}V=\frac{4\pi N p_0}{3}\frac{1}{1-\lambda_0\rho}$$

where V is the molal volume, ρ is the density and

$$\lambda_0=\frac{32\pi^2N^2p_0^2}{45B}\left(1+\frac{1}{3}\frac{A}{BRT}\right).$$

Here A and B are the constants of a van der Waals type equation of state. This expression becomes identical with the familiar Clausius-Mossotti relation in the limit of zero density. The formula is applied to dielectric constant measurements on several gases. AUTHORS.

1989. Rotation of Dielectrics in Electrostatic Fields. L. G. Vedy. *Cambridge Phil. Soc., Proc.* 27. *pp.* 91–102, *Jan.*, 1931.—The rotation of a dielectric covered body, suspended between the poles of a Wimshurst machine, is investigated and found to be due to the accumulation of charge on the surface of the body, under the action of the brush discharge, and to the subsequent electrostatic repulsion of this charge. It is shown theoretically, in an appendix, that the rate of rotation is governed by the rate of decay of the surface charge, and is a maximum for a certain value of this rate of decay. The rotation of a chain hanging from an electrical machine into the dielectric layer of a Leyden jar (the inner conducting coating being removed) and similar electrostatic experiments are described, and shown to be due also to the superficial charging of a dielectric body. [See also Abstract 1838 (1927).] AUTHOR.

1990. Free Rotation and Temperature Dependence of Molecular Polarisation of Propyl Chloride and 1 : 2 Dichloro-ethane. R. Sänger. *Phys. Zeits.* 32. *pp.* 21–26, *Jan.* 1, 1931.—This paper continues a previous investigation [see Abstract 3201 (1930)] whereby it is established that the molecular polarisation of 1 : 2 dichloro-ethane exhibits a perfectly normal temperature behaviour, and that the permanent electric moment of 1 : 2 dichloro-ethane may be explained by a relatively strong deformation of the valency tetrahedron of the two carbon atoms with retention of the possibility of an unhindered free rotation. A fresh measurement of propyl chloride shows the electric moment, as anticipated from previous theory, to be: $\mu = 2\cdot04_0 \pm 0\cdot007 \times 10^{-18}$, *i.e.*, no essential alteration from the moments of methyl and ethyl chlorides. H. H. Ho.

1991. Application of the Debye Dipole Theory to Binary Liquid Mixtures. Part III. J. M. Fogelberg and J. W. Williams. *Phys. Zeits.* 32. *pp.* 27–31, *Jan.* 1, 1931.—This paper continues a general investigation [see Abstract 604 (1929)] and considers derivatives of ammonia. Dipole moment data for a number of trivalent compounds of nitrogen have been obtained by means of the method of binary mixtures. Values for the dielectric constants and densities are also included, and the results discussed from the standpoint of the stereochemistry of the nitrogen atom. It is shown that the dipole moment of such a molecule can only be calculated, in general, when the group characteristic vectors are spatially considered, since the reciprocal effects between the groups (attractions and refutations) must be taken into account. The data are still insufficient for a complete theoretical presentation of the subject. H. H. Ho.

1992. Debye Effect in Viscous Dielectrics. G. Todesco. *N. Cimento*, 8. *pp.* 45–48, *Jan.*, 1931.—Results are given of measurements of h.f. resistances made by means of a coil immersed in petroleum, vaseline oil, extra-dense oil and castor oil. The data obtained render probable the existence, for castor oil, of an absorption band at the wave-length about 33 m. at 20° C. This result agrees with Debye's theory. T. H. P.

1993. Counting Ions in the Free Atmosphere. Y. Itiwara. *Phys. Zeits.* 32. *pp.* 97–106, *Jan.* 15, 1931.—The aspiration cylindrical condenser or counting tube is used to measure the total number of small and large ions in the free atmosphere. The tube may be used by obtaining (1) the decrease of charge on the inner electrode, or (2) the charge on an initially earthed inner electrode. The former is less sensitive and a longer time is required for an observation, but the latter although measured quickly produces errors from the field created near the opening where the air enters and only a fraction of the ions enter. While the Ebert counter measures the number of small ions per cc. of air the counting tube of Gockel and of Hess is stated by the author to give only the number of large ions per cc. because of this field effect. From his measurements the author applies a correction to Hess's results and this gives much better agreement with Nolan's figures. In an *Appendix*, **V. F. Hess** expresses doubt regarding Itiwara's results because of changes in field distribution with the air at rest or in motion, the effect of turbulent air motion in assisting ionic flow, and that the agreement obtained with Nolan's results was accidental. R. S. R.

1994. Inversion of the Earth's Electric Field under a Clear Sky. G. Aliverti and M. C. Montù. *N. Cimento*, 8. *pp.* 15–21, *Jan.*, 1931.—Observations at the Col d'Olen on Aug. 26, 1930, showed rapid changes in the atmospheric potential gradient, extending from + 228 to − 369 volts per m. The atmospheric conditions were quite normal. It is suggested that space charges may be formed at some distance, perhaps 100 km. from the station, where there is mist or cloudiness, and that winds of different intensity may carry off the separate positive and negative charges, so as to affect observations at a distance from the source of disturbance. J. H. A.

1995. Auroral Phenomenon. A. C. Burton. *Canad. J. of Research*, 4. *pp.* 52–53, *Jan.*, 1931.—A narrow and distinct arch of light was observed to stretch across the sky overhead from East to West, remaining steady in position for some forty minutes. A photograph, on microscopic examination, showed an unexpected fine structure that was not observed visually. AUTHOR.

1996. Experiments on Störmer's Auroral Theory. Part I. Flat Paths. E. Brüche. *Zeits. f. Astrophysik*, 2. 1. *pp.* 30–69, *Jan.* 15, 1931.—The author succeeded in producing threadlike luminous electronic rays of smaller velocity, and consequently the possibility of verifying Störmer's auroral theory arose. For electronic rays with a velocity of 200 volts, electronic paths typical of those in the earth's field can be imitated, and these are described in the paper and illustrated. In the first section the theory is reviewed and results relating to auroræ, magnetic disturbances and wireless echoes. The production of the electronic rays and their photography, a model of the earth as a magnet and its magnetic field and tests with the apparatus are treated successively. Dimensional considerations for the radius of the path and its approximate limits and a description of equatorial paths are examined. Finally, the theory relating to equatorial non-periodic and periodic single paths is investigated, and plates show the results of experiments made in illustration of these paths. The results are in agreement with theory and Störmer's statements, while some paths not yet known to theory are demonstrated. [See Abstract 1346 (1931).] R. S. R.

CURRENT ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM.

1997. Measurements with the Aid of Liquid Helium. Part XI. Resistance of Pure Metals at Low Temperatures. W. Meissner and B. Voigt. *Ann. d. Physik*, 7. 7. *pp.* 761–797, *Dec.* 29, 1930, *and* 7. 8. *pp.* 892–936, *Jan.* 5, 1931. *From the Reichsanstalt.*—The paper both extends and summarises previous work in this field. As far as possible, the results have been corrected to the completely pure metal, and the characteristic temperature has been calculated from the Grüneisen formula for the resistance-temperature relation. In general, measurements are made at about 0° C., at the boiling points of oxygen and nitrogen, and in the range covered by helium boiling at various pressures. Copious experimental details are given, both as to the thermometry and to the remainder of the technique. The first paper gives results (with details as to crystal structure, origin, treatment and purity of the specimens) for Li, Na, K, Rb, Cs, Cu, Ag, Au, Be, Mg, Ca, Sr, Ba, Zn, Cd, Hg, B, Al, In and Tl. In the second paper, results are given for C, Si, Ti, Zr, Ce, Th, Ge, Sm, Pb, V, Ta, As, Sb, Bi, Cr, Mo, W, U, Se, Te, Mn, Re, Fe, Ru, Co, Rh, Ir, Ni, Pd and Pt. Hg, In, Tl, Th, Sn, Pb, Ta, Ti, Ru, Nb, become superconductors at sufficiently low temperature. The characteristic temperatures are tabulated in the order of the periodic system, and it appears that in any group they decrease with increasing atomic number; exceptions are provided by the metalloids, which probably cannot be represented by a Grüneisen formula with a single term. J. H. A.

1998. Electrical Resistance at Low Temperatures and Effect of Magnetic Field. W. J. de Haas and J. Voogd. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 51–55, 1931. *Comm. No.* 212*d from the Phys. Lab., Leiden.*—The resistances of very pure indium, thallium and gallium have been measured at low temperatures, and it is shown that they all become superconducting. In the case of thallium, the effect of a longitudinal magnetic field has also been studied, and in particular the quantity $HW_{\frac{1}{2}}$, the magnetic field which in an increasing field restores the resistance to half its normal value, is plotted against temperature, and compared with $HW_{\frac{1}{2}}$ for mercury. J. H. A.

1999. Further Investigation on Magnetic Disturbance of Superconducting State of Alloys. W. J. de Haas and J. Voogd. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 56–62, 1931. *Comm. No.* 214*b from the Phys. Lab., Leiden.*—The resistance of a lead-bismuth alloy (35 % Bi) corresponding to the eutectic of the system has been examined in a magnetic field, as also that of a 40 % thallium in lead, 15 % mercury in lead and the gold-bismuth eutectic. The observations agree with the rule that on decreasing the temperature, the shift in the direction of high fields experienced by the magnetic transition figure is greater for alloys than for pure metals. J. H. A.

2000. Magnetic Disturbance of Superconductivity of Single-Crystal Wires of Tin. W. J. de Haas and J. Voogd. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 63–69, 1931. *Comm. No.* 212*d from the Phys. Lab., Leiden.*—The hysteresis and discontinuous phenomena occurring in rising and in falling magnetic fields are investigated. J. H. A.

2001. Resistance of Graphite, Thorium, Titanium and Titanium-Zirconium below 20·4° K. W. J. de Haas and P. M. van Alphen. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 70–74, 1931. *Comm. No.* 212*e from the Phys. Lab., Leiden.*—The graphite was a well-crystallised block of Ceylon graphite, and it does not show superconductivity down to 1·1° K. The residual resistance agrees with that found for powdered graphite. The thorium becomes a superconductor between 1·9 and 1·4° K., whilst titanium becomes a superconductor between 1·88 and 1·63° K. and the mixed crystals between 1·63 and 1·12° K. All these results are only in fair agreement with those of Meissner. J. H. A.

2002. Hall Effect in Weak Magnetic Fields. E. Bossa. *Accad. Lincei, Atti,* 12. *pp.* 582–583, *Dec.* 7, 1930.—A correction is given of some of the figures set out in a previous paper [see Abstract 3211 (1930)] which depend on the position of the zero of the amplifier, but the value of the mean results is not changed. J. J. S.

2003. Conduction of Electricity in Thin Films of Liquid Hydrocarbons. L. Brüninghaus. *Comptes Rendus,* 192. *pp.* 151–153, *Jan.* 19, 1931.—Further evidence showing that liquid hydrocarbons have a condition of high electrical conductivity when in thin films of thickness of about 10 μ. The results are explained by supposing that ions analogous to those found in air exist in these liquids. [See Abstract 3399 (1929).] G. C. McV.

2004. Nature of Conductivity of Insulating Oils. K. F. Herzfeld. *Phys. Rev.* 37. *pp.* 287–291, *Feb.* 1, 1931.—It has been shown in a previous paper [see Abstract 750 (1930)] how the methods developed in the study of conduction of electricity through gases could be applied to determine the nature of the ions present in liquids and solids. In the present paper these methods have been applied to the measurements of the space charge set up in insulating oils by a steady electric field, which were recently performed by Whitehead and Marvin [see Abstract 1467B (1930)]. The procedure is as follows: the shape of the curve shows that the current must be considerably below three-fourths of the saturation current. It is possible to fit the curve closely by assuming the Langevin constant to be $\beta = 36 \pm 10$. From this the number of ions present in the normal state and their mobility can be calculated, which turns out to be $3{\cdot}5 \,.\, 10^{-6} \pm 50\,\%$ cm./sec. per volt/cm. With the assumption that the mobility is inversely proportional to the viscosity, the mobility of these ions in water would be $1{\cdot}2 \,.\, 10^{-4}$ cm./sec. per volt/cm. or in the usual units 12. If one assumes that Lorenz's results for organic ions can be applied these ions should have approximately 110 atoms. From the boiling point of the oil one would conclude that the molecule of the oil contains about 45 atoms. AUTHOR.

2005. Variation of Spark-Potential with Temperature in Gases. H. C. Bowker. *Phys. Soc., Proc.* 43. *pp.* 96–111; *Disc.*, 111–112, *Jan.*, 1931.—The effect of temperature on spark-potential in hydrogen and nitrogen at ordinary pressures has been studied up to 860° C., over 6000 voltmeter readings having been taken. The spark-potential is found to depend on the density of the gas and to be independent of temperature and pressure for a given density. Additional ionisation of limited amount does not lower the spark-potential at ordinary densities. AUTHOR.

2006. Head Velocity of Electric Sparks and Lightning Flashes. R. Rüdenberg. *Wiss. Veröff a. d. Siemens-Konzern*, 9. 1. *pp.* 1–6, 1930.—Every electric spark or lightning flash represents a conduction or convection current, and must, therefore, in non-homogeneous fields be accompanied by a displacement current in the part of the field not broken down. By comparison of the laws holding within and without the spark it is deduced that the head of the spark has a finite velocity, which, for a particular case selected, has a value of about one-fourth of the velocity of light. Relativistic considerations show that the velocity of the head of the spark cannot rise much beyond a small fraction of the velocity of light. A. W.

2007. Time Characteristics of the Commencement of a Glow Discharge. M. Steenbeck. *Wiss. Veröff. a. d. Siemens-Konzern*, 9. 1. *pp.* 42–72, 1930.—Oscillograph records were obtained of the time characteristics of the commencement of glow discharges in rarefied gases between plane parallel electrodes. For photographic registration the phenomena must be repeated many times, and methods are described for effecting this with closely approximate synchronisation. The first part of the rise of current is calculated from Townsend's theory. The experimental results are in agreement with theory, which is also confirmed by the dependence of the value of the time constant of the rise of current on the electrode distance, the field strength being maintained constant; also on the molecular weight of the gas in the discharge chamber and on the pre-ionisation.

It was found that for all similar glow discharges the current density j is related to the pressure p according to the formula dj/dt = const. × p^3. This law was found to hold good for normal glow discharges for a pressure range of more than sixty-fold. Under certain conditions of abnormal kathode fall the current curve shows a pronounced maximum. This effect is capable of a quantitative explanation on the lines suggested by Güntherschulze, namely heating and consequent rarefaction of the gas. At higher gas pressures the current does not rise exponentially, but relatively quicker. This effect is explained as being due to field disturbances by positive space charges, in accordance with the Hippel-Franck electric breakdown theory. A. W.

2008. Distribution of Electric Force and Rise of Temperature in the Glow Discharge. J. M. Holm. *Phil. Mag.* 11. *pp.* 194–221, *Jan.*, 1931.—It is suggested that the results of Finch and Cowen [see Abstract 1886 (1926)] on gaseous combustion and ignition in electrical discharges might be explained equally well upon the thermal theory as upon the ionisation theory given by them. Experiments to test the accuracy of the two-probe method of determining the electric force in glow discharges are described. These lead to the conclusion that above a pressure of about 2 mm. of mercury the method gives the electric force with an error of less than 1 % in discharges passing through air or hydrogen. Graphs are given showing the distributions along the axis of a discharge tube of the rise in temperature obtained by means of a platinum thermometer and of the corresponding rate of dissipation of energy; the two are not found to be in exact proportion. The rise in temperature in the uniform positive column type of discharge is calculated, and the calculation shows that the rise in temperature should, to a first approximation, be proportional to the rate of dissipation of energy. The calculated values of the rise in temperature are found to be lower than the observed values. A possible explanation of this is given. A. W.

2009. Potential of the Walls in the Kathode Dark Space. Jean W. Beck and K. G. Emeléus. *Phil. Mag.* 11. *pp.* 54–64, *Jan.*, 1931.—The potential of the walls in the kathode dark space of a glow discharge has been measured by an electrostatic method for kathode falls in potential of not greater than 440 volts. The walls are strongly positive to the discharge close to the kathode and negative in the negative glow, so that walls and discharge are at the same potential in one place, which proves to be at the boundary of the negative glow and kathode dark space. The bearing of the results obtained on the measurements of potential made in the dark space by Brown and Thomson [see Abstract 1974 (1930)] is discussed briefly, and the difficulty of obtaining a theory of the wall potential pointed out. AUTHORS.

2010. Production of High-Speed Canal Rays without the Use of High Voltages. E. O. Lawrence and D. H. Sloan. *Nat. Acad. Sci., Proc.* 17. *pp.* 64–70, *Jan.*, 1931.—The principle of the methods developed by the authors was first demonstrated by Wideroe, who obtained in a vacuum tube potassium ions having kinetic energies corresponding to twice the maximum voltage applied to the tube, which was about 25,000 volts. In the present experiments mercury ions having kinetic energies of over 200,000 volts are obtained in a tube in which the maximum applied voltage is about 10,000 volts. The use of this technique is expected to lead to the production of canal rays of much higher speed, namely, 1,250,000-volt singly-charged mercury ions and 2,500,000-volt doubly-charged ions. The method is as follows: a series of metal tubes arranged in line are attached alternately to the inductance of a h.f. oscillatory circuit. A h.f. voltage applied in this manner produces at any instant electric fields of opposite direction and equal magnitude between successive accelerator tubes. If at one instant an ion finds itself between the first and second tubes it will be accelerated into the second tube, and if the time consumed in passing through this tube is equal to the half-period of the oscillator it will arrive between the second and third tubes with the field reversed in direction in such a manner that it will receive an additional acceleration on passing into the third tube. Hence, if the tubes are made successively longer in the proper way, for every frequency of the applied oscillations there will be a corresponding voltage such as will cause the ion to move up through the series of tubes in synchronism with the oscillating field, gaining between each pair of tubes an increase in kinetic energy corresponding to the applied p.d. This arrangement is not applicable to speeding up electrons to high kinetic energies because of the high speed involved. No particular efforts were made to produce large ionic currents. The actual currents obtained were of the order of magnitude of 10^{-10} amp. H. L. B.

2011. Temperature and Generation of Heat in the Positive Column of the Electrical Discharge in Argon. W. Pupp. *Zeits. f. Physik*, 67. 5–6. *pp.* 297–310, *Jan.* 31, 1931.—The " mean " temperature of a section of the positive column is determined by the gas displaced at constant pressure, anodes being interposed successively at different distances from the kathode. The smooth course of the curve connecting the temperature with the current strength and the gas pressure shows marked irregularities at certain points, which are attributed to the influence of wandering layers. The author considers this influence to have been much under-estimated hitherto. By means of the theory of heat conduction it is possible to calculate from the temperatures obtained the heat generated in the interior of the positive column, which may be compared with the power supplied. This also gives the heat generated at the bounding wall of the positive column. H. L. B.

2012. Electron Beam Discharge in Argon. J. Duffey. *Leeds Philosoph. and Lit. Soc., Proc.* 2. *pp.* 163–167; *Disc.*, 168, *Jan.*, 1931.—Electron beam phenomena at low pressures are described and space-potential measurements obtained by the use of a cold exploring electrode are given. It was found that the edge of the glow maintained a constant potential of about 60 volts positive with respect to the filament. This value was not affected appreciably by the factors which altered the size of the glow, namely, pressure, anode potential and filament emission. Increase of any one of these three factors resulted in an increase of space-potential at all points in the discharge, as far as could be measured. While certain features of the discharge can be explained on the ordinary space-charge theory, there are some points still obscure. A. W.

2013. Efficiency of an Electron Gun. J. E. Taylor. *Leeds Philosoph. and Lit. Soc., Proc.* 2. *pp.* 169–173, *Jan.*, 1931.—An improved type of electron gun is described in which better focussing and higher beam efficiency are obtained by interposing between the emitting filament and the gun nozzle a negative screen with a small central hole. This screen has low negative potentials applied to it. Curves are given which show that maximum efficiency is attained at a certain screen potential which varies with the accelerating potential. The action of the device is similar to that of a " soft " triode valve. [See also Abstract 2286 (1930).] A. W.

2014. New Appearance in the H.F. Discharge. (Miss) M. Chenot and G. Ferrié. *Comptes Rendus*, 192. *pp.* 38–40, *Jan.* 5, 1931.—The new phenomenon is observed at frequencies corresponding to wavelengths less than 10 m., and at pressures less than 0·001 mm. of Hg. In a glass tube 50 cm. long and 1·8 cm. internal diameter, with external electrodes, a series of bright patches of equal length, with dark spaces between, were observed, resembling a system of stationary waves; and a test with a Hertz resonator along the tube showed that such a system of waves really existed. This implies that waves pass along the tube from the excited end, and are reflected at the other end. The velocities of propagation vary between 3 and 5 hundredths of the velocity of light. G. Ferrié suggests that the phenomena recently described by Mahout and Guillet may be due to a propagation of movements of the free electrons of a metal, similar to that found by the author in a discontinuous medium made up of electrified particles. Ferrié has already suggested that the retarded echoes observed in wireless telegraphy may be due to such greatly reduced velocities of propagation. H. N. A.

2015. H.F. and D.C. Discharges in Helium. F. L. Jones. *Phil. Mag.* 11. *pp.* 163–173, *Jan.*, 1931.—Experiments are described which show that the mean electric force in the uniform glow in h.f. discharges in helium is the same as in the uniform positive column of d.c. discharges, for pressures from 1 to 35 mm. in a discharge tube of internal diameter 2·9 cm. The results are thus in agreement with Townsend's theory of the electrodeless discharge [see Abstract 1351 (1928)]. A. W.

2016. H.F. Discharges in Mercury, Helium and Neon. C. J. Brasefield. *Phys. Rev.* 37. *pp.* 82–86, *Jan.* 1, 1931.—Measurements were made of the potential drop at the electrodes and the electric force in the positive column of h.f. discharges in mercury, helium and neon for a large number of gas pressures and for frequencies of oscillation between 1·25 and 22·5 megacycles. The results showed that in general the magnitude of the electric force was too small to produce electrons whose velocity would be sufficient to ionise or excite the gas. It was observed that as the frequency of oscillation increases, the potential drop at the electrodes decreases. Considering the total voltage between electrodes it was found that the h.f. discharge in mercury has its maximum conductivity when operated at a frequency of 17·5 megacycles (17·15 m.) and at a pressure of 0·002 mm.; the discharge in helium has its maximum conductivity at 17·5 megacycles and 0·33 mm. pressure; the discharge in neon has its maximum conductivity at 7·5 megacycles (40 m.) and 1·0 mm. pressure. [See also Abstract 3528 (1930).] AUTHOR.

2017. Mobility of Gaseous Ions. P. Goldmark and F. Kammer. *Akad. Wiss. Wien, Ber.* 139. 2. A. 5–6. *pp.* 241–253, 1930.—A new method is developed for measuring the mobility of gaseous ions. F. J. W.

2018. Recombination in Mercury Vapour. H. W. Webb and D. Sinclair. *Phys. Rev.* 37. *pp.* 182–193, *Jan.* 15, 1931.—The afterglow in ionised mercury vapour is studied as a recombination phenomenon, to determine how its intensity varies with concentration of electrons and of positive ions, vapour pressure and the mean energy of the electrons. The afterglow is observed in a region outside the arc to which positive ions and electrons are carried by a stream of vapour. The intensity of the visible part of the afterglow radiation is shown to be closely proportional to the total intensity under the experimental conditions, and is therefore used as a measure of the rate of recombination. The results suggest that the recombination in mercury vapour takes place in two stages, of which the second is responsible for the radiation of the series lines, and that the effect of the fast electrons is to re-ionise from the first stage. H. L. B.

2019. Ionisation During the Oxidation of Phosphorus Vapour. J. Tausz and H. Görlacher. *Phys. Zeits.* 32. *pp.* 91–97, *Jan.* 15, 1931.—The ionisation produced during the oxidation of phosphorus in air or oxygen varies with the rate of flow of the gas, the temperature and the surface area of the phosphorus. In stationary air the ionisation increases at first rapidly and then at a decreasing rate. The ionisation rises to a maximum with increase of the rate of flow of the gas, and thereafter falls, whilst with increase of the surface it rises to a constant value corresponding with the attainment of the saturated vapour pressure. The rate of increase of ionisation with temperature is greater at the higher rates of flow. In moist oxygen at 20° C. no ions are produced, but in total absence of water strong ionisation and formation of fog occur, without, however, the production of phosphorescence. "Poisons," such as benzene and other hydrocarbons, reduce the ionisation to an extent roughly proportional to their activity. H. F. G.

2020. Carrying of Atoms by a Magneto-Kathodic or Kathodic Beam. E. Henriot, O. Goche and (Miss) F. Dony-Hénault. *J. de Physique et le Radium*, 2. *pp.* 1–11, *Jan.*, 1931.—Electrons from a heated tungsten, platinum or carbon filament are passed through a slit in a plate anode, and then, with or without the further aid of a magnetic field, across vaporised sodium or sulphur. They carry with them atoms of these substances, and deposit them on a suitably placed plate in the same position of impact as the electrons would have reached alone. If sufficiently heated the filament itself will supply both electrons and atoms (or ions). Such a mixed beam is deviated as a whole by an electromagnetic field. The atoms thus carried along can, however, be separated from the flux of electrons by passing the mixed beam into a strong opposing field, which turns aside the electrons, while the released atoms pass on. No definite explanation is offered. C. A. S.

2021. Effect of Resolving Power on Measurements of the Absorption Coefficient of Electrons in Gases. R. R. Palmer. *Phys. Rev.* 37. *pp.* 70–81, *Jan.* 1, 1931.—The absorption coefficient of electrons has been studied as a function of the resolving power of the experimental apparatus. An electron beam of 0·4 mm. radius was used in a Mayer type of apparatus in which the opening at the end of the scattering chamber was of variable aperture. Values of the absorption coefficient were obtained in helium and in mercury vapour for 20, 40, 80 and 135 volt electrons over an angular aperture range of from 2° to 11° as measured from the end of the electron gun. All curves showed a definite decrease in the absorption coefficient with increase in angular aperture. These curves were corrected for the positive ion current, from the efficiency of ionisation data of Bleakney and Smith, to give curves for the total number of electrons collected as a function of the size of the opening. These showed also a definite decrease with increase in aperture, corresponding to a preference for scattered electrons to be deflected through small angles. In helium the curves were steeper the higher the electron velocity, indicating that this preference is more decided for fast electrons than for slower electrons. In mercury vapour the curves were more nearly alike. The results do not indicate as decided a preference for small angle scattering as is indicated by the angular distribution curves of Arnot in mercury vapour. This discrepancy is not explained. AUTHOR.

2022. Angular Scattering of Electrons in Gases. F. L. Arnot. *Cambridge Phil. Soc., Proc.* 27. *pp.* 73–76, *Jan.*, 1931.—The author has recently explained [see Abstract 965 (1931)] the way in which a radial electric field is set up around an electron beam of a few μA. intensity, which passes through a gas at a pressure of a few thousandths of 1 mm. The magnitude of this field can be found by measuring the concentration of the electrons in the beam, and at a point outside it. Discusses the error introduced into experiments on the angular scattering of electrons in gases by this potential gradient at right angles to the beam. Obtains an equation showing the relation between the true and the observed angles of scattering. In the author's work on scattering in Hg vapour the error introduced into the scattering angle by this effect was in all cases less than 0° 17′, or less than the experimental error in measuring the angle. With electron beams of about 20 μA. intensity the scattering curve for 20 or 30 volt electrons might be appreciably distorted. H. N. A.

2023. Capture of Electrons by Protons. K. Wolf. *Ann. d. Physik*, 7. 8. *pp.* 937–946, *Jan.* 5, 1931.—Tests were made by a photographic electrometric method to find whether the capture of electrons by protons could be observed, but no phenomenon analogous to the capture of electrons by α-particles described by Davis and Barnes was found. [See Abstract 2579 (1930).] J. J. S.

2024. Electron Diffraction by Oxygen-Coated Tungsten. W. Boas and E. Rupp. *Ann. d. Physik*, 7. 8. *pp.* 983–1000, *Jan.* 5, 1931.—Reference is made to a paper by G. P. Thomson [see Abstract 258 (1931)]. In the present experiment slower electrons are used to measure the diffraction pattern given by tungsten. The apparatus is described in detail, and sources of error are discussed. Experiments with pure tungsten gave a mean inner potential, E_0, of 10·5 ± 1 volts for 37 maxima, the angles of incidence, θ, of the electrons being 85°, 80°, 75°, 60°, 30°. At the angles $\theta = 85°$ and 80° maxima were found having the value 0 for E_0 as well as 10·5. When the tungsten was covered with a layer of oxygen nine maxima were obtained, which could be interpreted in terms of a lattice constant 4·46 ± 0·1 Å., the above value being assumed for the inner potential of tungsten. This oxygen layer on tungsten thus discovered by means of electron diffraction has the properties attributed by Langmuir to a monomolecular layer of oxygen. H. L. B.

2025. Diffraction of an Electron Wave at a Single Layer of Atoms. M. v. Laue. *Phys. Rev.* 37. *pp.* 53–59, *Jan.* 1, 1931.—This paper undertakes to estimate the influence of the gradual transition between the field exterior to, and in the interior of a crystal, on the diffraction of electrons.

This gradual transition is required by electrostatics. The result is that this influence may be neglected for electrons whose energy is 200 volts or more. One can then treat the transition as discontinuous. In the case of slower electrons it seems doubtful if such a treatment is permissible.
AUTHOR.

2026. Sharpness of Diffraction Maxima Produced by Electron Waves. E. Schöbitz. *Phys. Zeits.* 32. *pp.* 37–39, *Jan.* 1, 1931.—A stream of electrons produced thermionically is resolved into a magnetic spectrum, and a narrow band of the spectrum is transmitted through very thin gold foil and received on a photographic plate. To obtain good patterns it is found necessary to keep the pressure in the vacuum apparatus below 10^{-5} mm.; the minimum pressure used was $3\cdot10^{-8}$ mm., and the maximum number of rings obtained was eighteen. If r is the radius of a diffraction ring and dr the width of the ring, the ratio r/dr may be taken as a measure of the sharpness. It is found that the sharpness depends only very little on the thickness of the gold-foil. When the thickness is decreased from $8\cdot10^{-6}$ cm. to $1\cdot5\cdot10^{-6}$ cm. no appreciable change of sharpness occurs; but there is a considerable increase in the darkening of the background of the photograph as the thickness of the foil is increased. On the other hand, the sharpness depends considerably on the wave-length of the diffracted electrons. A change of wave-length from 0·065 Å. to 0·045 Å. causes the width of the rings to diminish to a third of their value. H. L. B.

2027. Reflection Polarisation of Electron Waves. O. Halpern. *Zeits. f. Physik,* 67. 5–6. *pp.* 320–332, *Jan.* 31, 1931.—The reflection polarisation of electron waves is discussed mathematically and shown to be qualitatively different, in the case of reflection by a two-dimensional lattice, from that calculated by Mott for the case of an isolated scattering nucleus. If the scattering material in the theory is replaced by the periodic characteristics of a plane lattice, without any further postulation as to the nature of the potential or Fourier coefficients, then the existence of polarisation in the scattered wavelets is readily deduced. The magnitude of the effect depends upon the character of the field of force and the lattice surface. Approximately, the effect varies as the square of the ordinal number of the scattering element. [See Abstract 3254 (1929).] J. S. G. T.

2028. Thoriated Tungsten and Molybdenum. A. Gehrts. *Zeits. f. techn. Physik,* 12. 2. *pp.* 66–71, 1931.—The activation of tungsten and molybdenum by admixture of thorium oxide and thermal treatment may be explained without recourse to induced volatilisation by the assumption that reduced thorium wanders along the limiting surfaces of the crystals. E. E. F. d'A.

2029. Effect of Space Charge in a Gas at Low Pressures. E. W. B. Gill. *Phil. Mag.* 11. *pp.* 95–98, *Jan.,* 1931.—The author has shown in a previous communication [see Abstract 1955 (1925)] that with an ordinary triode it has been found under certain conditions that, when definite potentials are applied to the electrodes, the current passing through the valve from filament to anode can have two or three different values. This effect is more readily obtained if the applied potentials are small, *i.e.,* from 10 to 30 volts. Although the potentials of the electrodes themselves are the same, yet the potential distribution in the space between them is different with the different currents. The present work records observations with a diode containing gas at low pressures, the applied potential being small and of the order of that usually quoted as the ionisation potential of the gas. Such a valve is described in detail together with experimental conditions. The emission currents, measured whilst the filament was kept at a bright red heat, remained very small until the electrode p.d. reached about 20 volts, after which a rapid rise occurred. If the changes in potential are made intermittently, the currents obtained with increase of potential are the same as those for decreased potential, *i.e.*, there is no hysteresis. If, however, the potential variation is continuous by means of a potentiometer, this is no longer the case, and a different value of the current can exist for the same voltage according as the previous step is one of increment or decrement. A magnetic field applied parallel to the filament while the smaller current is running causes the current to increase immediately to a higher value, and on removal of the magnetic field the current remains at the high value. A simple explanation of these phenomena is offered. The currents passing are limited by the negative space charges, and the increase of current when ionisation occurs is due not so much to the actual magnification of the current by ionisation as to the neutralisation by the positive ions of part of the negative charge in the gas. The possibility of two currents for any p.d. in the region of the ionising potentials in the simple case of two electrodes is established and the explanation is suggested. S. G. B.

2030. Emission of Electrons under the Influence of Chemical Action at Lower Pressures. O. W. Richardson and L. G. Grimmet. *Roy. Soc., Proc.* 130. *pp.* 217–238, *Dec.* 2, 1930.—The electron emission which is set up when phosgene reacts with sodium-potassium alloy has been measured directly down to pressures of 10^{-5} mm. and to extrapolated pressures of $5\cdot10^{-7}$ mm. The alloy was allowed to form at a jet as a drop, which then fell through the phosgene. The results show that the emission is a function of the gas pressure; it increases continuously to a critical value at about 10^{-3} mm., above which the saturation current rapidly approaches an upper limit. The saturation current is inversely proportional to the time taken by the drop to form, and, therefore, the greatest charge emitted by a drop is independent of the time it takes to form. Evidence is brought to show that the experimentally-determined function describing the velocity distribution of the electrons approaches a limit as the pressure is reduced. F. J. W.

2031. Photoelectric and Thermionic Properties of Rhodium. E. H. Dixon. *Phys. Rev.* 37. *pp.* 60–68, *Jan.* 1, 1931.—A thin ribbon of rhodium was subjected to rigorous heat treatment at 950°–1450° C. for 1050 hours in a final vacuum of 10^{-8} mm. of Hg in order to put it in a stable condition for photoelectric and thermionic measurements. During this period the long wave limit shifted from about 2530 Å. to 3150 Å., and then shifted back to 2509 Å., where it remained during the last 375 hours of heat treatment. The photoelectric current was found to increase about 130 % as a result of increasing the temperature of the rhodium from 25° to 950° C. A rather sudden increase took place at about 240° C. The photoelectric work function at 25° C. was determined from the final long wave limit of 2482–2536 Å. to be $4\cdot92 \pm 0\cdot06$ volts. The long wave limit at 240° C. was 2652–2752 Å., which gave a photoelectric work function of $4\cdot57 \pm 0\cdot09$ volts for this temperature. No further change in long wave limit was observed up to 650° C. An anomaly was observed at 1100° C., where the thermionic current was irregular and where the rate of change of the resistance of the rhodium with temperature changed on increasing the temperature. The thermionic work function of rhodium, as determined from observations and with Richardson's equation, was $4\cdot58 \pm 0\cdot09$ volts. This value agrees with the photoelectric work function at 240° C. Pure hydrogen and oxygen were introduced separately into the experimental tube while the rhodium was in its outgassed equilibrium condition. In the case of hydrogen the wave limit was changed from 2482–2536 Å., to 2378–2482 Å. In the case of oxygen the wave limit was changed from 2482–2536 Å. to a value so low that it could not be determined by the method used in this work. AUTHOR.

2032. Influence of Nitrogen-Oxygen Compounds and their Components on the Photoelectric Sensitiveness of Potassium. R. Fleischer and H. Teichmann. *Zeits. f. Physik*, 67. 3–4. *pp.* 184–191, *Jan.* 21, 1931.—In continuation of those previously described [see Abstract 2649 (1930)], measurements are given of the influence of NO, NO_2, O and N on the ultra-violet sensitiveness of a layer of potassium. It is shown that the previously described change of the selective maximum of a layer of potassium treated with NO from the wave-length 334 $m\mu$ to 365 $m\mu$ is to be attributed to the formation of NO_2. J. J. S.

2033. Demonstration of the Temperature Dependence of the Photoelectric Effect of the Sensitive Layer. H. Teichmann. *Zeits. f. Physik*, 67. 3–4. *pp.* 192–193, *Jan.* 21, 1931.—An arrangement is described which makes possible an easy cooling of a Cu-Cu_2O cell by liquid air, and thus enables an audience to be shown the dependence on temperature of the photoelectric effect of the sensitive layer. The arrangement shows that the current thus produced in a Cu-Cu_2O cell attains a maximum value in a definite region of temperature, − 80° to − 110° C. J. J. S.

2034. Variations in Photoelectric Sensitivity. J. Werner. *Zeits. f. Physik*, 67. 3–4. *pp.* 207–226, *Jan.* 21, 1931.—In a high vacuum metals and salts exhibit a photoelectric effect which is unaffected by the action of the incident radiation and gradually attains a maximum. When there is no high vacuum the emission is reduced owing to the presence of an adsorbed gaseous layer. The removal of this layer by scraping leads to increase of emission; this shows that the layer increased the work of escape of the electrons. In the case of zinc and aluminium an adsorbed layer occurs which cannot be removed by evacuation; the presence of this layer is accompanied by a strong increase in the emission. The effect appears to be superimposed on the fatigue effect, which it greatly exceeds in power. It appears to be due to the formation of a surface potential. In the case of platinum the adsorbed gas-layer which cannot be removed by evacuation leads to a gradual decrease of photoelectric sensitivity. This layer forms a badly conducting barrier which, as in the case of salts, causes a diminution of the supply of electrons at the surface. H. L. B.

2035. Photoelectric Properties of Catalysts used in Ammonia Synthesis. A. K. Brewer. *Am. Chem. Soc., J.* 53. *pp.* 74–83, *Jan.*, 1931.—In the synthesis of ammonia, the unpromoted iron catalyst made from reduced magnetite has the same photoelectric threshold as catalytic iron; both show no temperature coefficient over the range investigated. The aluminium oxide-promoted iron catalysts also have the photoelectric properties of pure iron. Hence the surface forces for pure iron and reduced magnetite are identical, no free Al collects on the surface of the promoted catalyst, and the concentration of any Al_2O_3 on the surface must be small. The photoelectric properties of iron catalysts containing K_2O and $K_2Al_2O_4$ differ greatly from those of pure iron; the emissivity increases markedly with the temperature, just as with oxide-coated filaments, dissociation of the K_2O at high temperatures being thus indicated. The long wave-length limit lies between those for Fe and K, showing the surface to be sparsely covered with elemental potassium; the ratio of the latter to the total K content is greatly reduced by the presence of Al_2O_3. The photoelectric properties of the $K_2Al_2O_4$-promoted catalyst appear to come from the K_2O which has failed to combine with the Al_2O_3. The poisoning action of K_2O may be due to free potassium, which is readily formed by dissociation. T. H. P.

2036. Recent Developments in Photoelectricity. C. E. Mendenhall. *Science*, 73. *pp.* 107–113, *Jan.* 30, 1931.—Summarises the various stages of development in the theory and experimental investigation of the photoelectric effect. Attention is drawn to the important results obtained by the application of statistics and wave-mechanics, and certain unsolved problems are discussed. The difficulty is pointed out of correlating theory based on the supposition of idealised surfaces with the results obtained experimentally with surfaces that are never truly smooth. H. L. B.

2037. Photoionisation of Caesium Vapour. K. Freudenberg. *Zeits. f. Physik*, 67. 5–6. *pp.* 417–432, *Jan.* 31, 1931.—The ionisation of caesium vapour takes place according to the equation $Cs^{*}+Cs = Cs_2^{+}+e$. Photoionisation can also be obtained with the blue Cs line $1s$–$3p$ and with the red Cs line $1s$–$2p$. From the dependence of the ionisation effect produced by these lines upon the radiation intensity, the pressure, and the temperature of the gas, the work of ionisation is calculated to be 3·17 volts per cæsium molecule, the energy of dissociation 0·35 volt per molecule, and the energy of dissociation of the ion 1·05 volts. E. E. F. d'A.

2038. Propagation of Electromagnetic Waves in a Refracting Medium in a Magnetic Field. D. R. Hartree. *Cambridge Phil. Soc., Proc.* 27. *pp.* 143–162, *Jan.*, 1931.—In a previous paper [see Abstract 1962 (1929)] a discussion was given of the propagation of electromagnetic waves in an isotropic stratified medium. In this paper the equations of propagation for such waves in an optically anisotropic stratified medium are obtained from the treatment of the refracted wave as the resultant of the incident wave and wavelets scattered by the elements of volume of the medium, and are reduced to a simple form. The primitive property of the medium, from which the other optical properties are derived, is the scattering tensor, relating the induced dipole moment per unit volume to the applied electric field. The relation between the dielectric tensor (corresponding to the dielectric constant of an isotropic medium) and the scattering tensor is obtained. A medium consisting of classical oscillators in an external magnetic field is then considered, the scattering tensor and dielectric tensor are evaluated and a formula for the refractive index is obtained. For an ionised medium the formula differs from that obtained by Goldstein. The difference is due to the inclusion of a term omitted by the latter; the significance of this term is discussed and its inclusion justified. Taking this term into account makes an important difference to the properties of the medium for long waves; this difference is illustrated by an example. A. W.

2039. Dispersion of Hertzian Waves in Solids. J. Errera. *Comptes Rendus*, 192. *pp.* 223–225, *Jan.* 26, 1931.—Contrary to the results of Frayne, Kobeko and Kurtschatov a crystal of potassium-sodium tartrate shows marked anomalous dispersion for frequencies of the order of 10^5, though the compressed powder shows none. The specific inductive capacity, ϵ, is much greater for low than for high frequencies, due possibly to increase in the number of dipoles within the crystal. If a continuous field is superposed on the alternating field ϵ decreases, the decrease increasing as the continuous field increases. Similar but less marked results are obtained with the powdered salt, ice and solid nitrobenzene. C. A. S.

2040. Detectors. G. Siemens and W. Demberg. *Zeits. f. Physik*, 67. 5–6. *pp.* 375–387, *Jan.* 31, 1931.—Experiments are described on a number of detectors. With lead sulphide almost the whole of the fall of potential across the detector was found between the platinum point and the lead sulphide preparation. With Kahlbaum's PbS the potential fall was, for equal applied potentials, greater when the platinum point was positive than when it was negative. The potential fall in the preparation itself and between it and the metal plate holding it was found to be very small. Within the material the fall of potential is independent of the direction of the current and Ohm's law is satisfied. PbS sublimated once behaves just like non-sublimated material, but with material twice sublimated, which exhibits no detector action, the potential fall between point and material is very small. With increasing number of points the current strength also increases, the difference between the current strengths in the two directions, however, becomes less and less, the current-potential curve approximates more and more to a straight line, so that the relation between current and potential approximates to Ohm's law for a large number of points. With H_2, N_2, O_2 and CO_2 in both the damp and dry state the effects observed with PbS once sublimated were the reverse of those obtained *in vacuo* using loose contacts. The results appear to render Vrede's theory untenable [see Abstract 3238 (1930)]. A. W.

2041. Survey of Magnetic Fields by Means of Electron Rays. E. Brüche. *Zeits. f. techn. Physik*, 12. 2. *pp.* 94–98, 1931.—It is explained how the electron rays previously described [see Abstract 607 (1931)] may be used to study magnetic fields. In particular a method is described suitable for use with relatively strong non-homogeneous fields of between 1 and 100 gauss. The method determines the curvature of the electron ray path from point to point and thus enables the whole field to be surveyed. Illustrations are given of the application of the method to two- and three-dimensional problems. A. W.

2042. Formulæ for the Strength of the Magnetic Field of a Cylindrical Coil. R. F. H. Chao. *J. Math. Phys., Mass. Inst. of Technology*, 10. *pp.* 13–18, *Jan.*, 1931.—Employing the methods of zonal harmonics, it is shown how to compute the magnetic field due to a circular filament or a solenoid at any point. Appendices give the zonal harmonic functions and their first derivatives, both of which are needed in the calculations. G. E. B.

2043. Magnetostriction of Overstrained Materials. J. S. Rankin. *Roy. Techn. Coll. Glasgow, J.* 2. *pp.* 385–395, *Jan.*, 1931.—This continuation of a previous paper [see Abstract 2304 (1930)] deals with the effect produced by permanent stretch and by wire-drawing on the change in length observed when iron, steel and nickel are magnetised. A tentative theory is advanced which attributes this effect of overstrain to the elastic internal stresses which it produces in the material. AUTHOR.

2044. Magnetic Susceptibilities of Polyoxymethylenes and Formaldehyde Solutions. W. Good. *Roy. Techn. Coll. Glasgow, J.* 2. *pp.* 401–409 *Jan.*, 1931.—The magnetic susceptibilities of the polyoxymethylenes and of formaldehyde solutions have been measured. The values found for the former are not in agreement with the theoretical values calculated for the formulæ which have been proposed to represent their constitution. The experimental results are tentatively accounted for and seem to lend support to the view that the polymers consist of small elementary units held together by strong crystal lattice forces. AUTHOR.

2045. Curie Points. L. F. Bates. *Phys. Soc., Proc.* 43. *pp.* 87–95; *Disc.*, 95, *Jan.*, 1931.—Attention is directed to the fact that at least three temperatures may require to be specified in a description of the magnetic behaviour of a ferromagnetic substance. These are respectively termed the ferromagnetic critical point, the ferromagnetic Curie point and the paramagnetic Curie point. The significance of the relative positions of the last two points is discussed, and it is shown that a slight extension of the view that ferromagnetism is due to a magnetic particle consisting of a group of associated atoms may account for the paramagnetic behaviour of iron, nickel and cobalt, and for that of more complicated substances such as the ferrocobalts, magnetite and manganese arsenide. AUTHOR.

2046. Critical Anisotropy Point of Ferromagnetic Crystals. N. S. Akulov. *Phys. Zeits.* 32. *pp.* 107–108, *Jan.* 15, 1931.—A mathematical discussion of the influence of the vector of magnetisation upon the physical characteristics of ferromagnetic crystals and their modification by magnetic influences. This vector I is discussed at length. Taking the change in resistance he propounds the following rule: when two curves for a function of I cut each other, the two curves corresponding to two different directions of magnetisation (S), then the curves for chosen values of S will also go through this point. Enlarging on his formulæ the author suggests methods for experimental verification, and points out that if the value $I_g = 800$, is divided by the number of atoms per cubic cm., then the result approximates closely to the value of the Bohr magneton. The significance of this is yet to be interpreted. S. G. B.

2047. Specific Heat of Electricity in Ferromagnetics. E. C. Stoner. *Leeds Philosoph. and Lit. Soc., Proc.* 2. *pp.* 149–158, *Jan.*, 1931. —The thermoelectric power curve of a ferromagnetic metal against, say, platinum shows a change of slope in the neighbourhood of the Curie point which corresponds to a sudden change in the Thomson coefficient, or specific heat of electricity σ. The increase in σ_e the specific heat of electricity per electron is numerically of the same order of magnitude as the decrease in the specific heat per atom S_a. The value of σ is not always of the same sign, and the free electron theory based on Fermi-Dirac statistics is incapable of accounting for positive values of σ. It is shown that the respective changes at the Curie point are related by the equation: $f\Delta\sigma_e = -\Delta S_a$, where f is the number of " missing " electrons per atom. This gives a result in agreement with that of Dorfman for nickel. G. E. A.

2048. Diamagnetism of Polyhalides. W. Gray and J. Dakers. *Phil. Mag.* 11. *pp.* 81–95, *Jan.*, 1931.—Values for molecular diamagnetism of various halides are recorded by Dakers. These are then discussed by the method previously given [see Abstract 4109 (1930)]. With the polyhalide anions in general it is clear that one of the halogen atoms has a special function in the constitution, and seems to act as a kernel round which the other halogen atoms are clustered. Perchloride of tetraethylammonium affords the only exception to the rule that this kernel must be either iodine or bromine. With this one exception, every polyhalide anion has, for at least one of its atoms, either iodine or bromine. The ability to act as a kernel appears to increase with the tendency to positiveness, the order being: Cl—Br—I. By assigning to each clustered halogen atom the negative valency 1, and to the kernel atom one of the positive valencies 1, 3, 5, 7, the charge on the complex anion can be explained. In this way neutral groups may be obtained, whose theoretical diamagnetism, when compared with the experimental diamagnetism of the molecule, is found to be greater than the latter by so much that the most likely reason is the development of homopolar bonds in which there is a fluctuation of angular momentum causing feeble paramagnetism. Concrete examples are given, and the paper resolves itself into a well-digested summary of the various factors involved. S. G. B.

2049. Diamagnetism of Free Electrons. C. G. Darwin. *Cambridge Phil. Soc., Proc.* 27. *pp.* 86–90, *Jan.*, 1931.—Landau has recently shown [see Abstract 989 (1931)] that when electrons are moving freely in a magnetic field they exhibit, in addition to the paramagnetic effect of their spin, a diamagnetic effect due to their motion. Bohr has shown that the motion of the electrons must be confined to some region by means of a boundary wall, and the electrons near the wall describe a succession of circular arcs, repeatedly bouncing on the wall, and slowly creeping round it in the direction opposite to that of the uninterrupted circles; when the moment of these electrons is taken into account, it exactly cancels out that due to the free circles. The author considers a special case, admitting of exact solution, which takes the boundary into account, and so makes it possible to follow more closely the analogy between the classical and quantum problems. The result obtained agrees with Landau, and seems to be correct in all cases where the density is not so great or the temperature so low that the Exclusion Principle must be applied. H. L. B.

2050. Diamagnetism of Free Electrons. E. Teller. *Zeits. f. Physik*, 67. 5–6. *pp.* 311–319, *Jan.* 31, 1931.—The diamagnetic orbital moment of free electrons enclosed in a chamber is calculated by determining the current produced in the chamber walls by a magnetic field. The result confirms that obtained by Landau [see Abstract 989 (1931)].

J. S. G. T.

2051. Force Required to Stop a Moving Electrified Sphere. Part II. G. F. C. Searle. *Roy. Soc., Proc.* 130. *pp.* 389–394, *Jan.* 1, 1931.—When an electrified sphere, which has no mass, is rigid and does not affect the electric field, is suddenly stopped, each element of charge $d\theta$ on it gives rise to a spherical electromagnetic wave with its centre at the element. This wave acts on all elements of charge which it meets, and, since the electric force in the wave has a component in the direction in which the sphere was originally moving, this sphere experiences as a consequence a resultant force urging it in this direction. In order to prevent the motion of the sphere after stoppage it becomes necessary to apply an equal but opposite force. This force evidently vanishes at a time after stoppage which is equal to the diameter of the sphere divided by the velocity of light. The value of this force was obtained by the author in 1907 for the case of spheres with surface and volume electrification, respectively, and moving with the velocity of light [see Abstract 1691 (1907)]. In the present paper this force is calculated for the case of a sphere with a surface charge and moving with a velocity less than that of light. The method consists in finding the force necessary to stop the motion of a point-charge and then integrating this force over the whole sphere. H. L. B.

2052. Quantistic Electrodynamics. E. Fermi. *Accad. Lincei, Atti*, 12. *pp.* 431–435, *Nov.* 2, 1930.—The author has recently given the equations of electrodynamics in quantistic form [see Abstract 1196 (1930)]. The results are particularly simple. The Hamiltonian that, in the sense of the principle of correspondence, represents the natural quantistic translation of classical electrodynamics, is obtained simply by adding to the Hamiltonian of Dirac's irradiation theory, a term that represents the electrostatic energy of the system of electric charges, so that in the present form the quantistic electrodynamics is not more complicated than Dirac's irradiation theory. This simplification is attained by means of a suitable expression of the condition $\frac{1}{c}\cdot\frac{\partial V}{\partial t} + \operatorname{div} U = 0$ that connects the scalar and vector potentials, and that also in the theory of Heisenberg and Pauli constitutes one of the most characteristic elements of quantistic electrodynamics. The theory retains two fundamental defects that are not so much of electrodynamic origin as derived from incomplete knowledge of electronic structure. These are the possibility that the electron of Dirac possesses of passing to energetic levels with negative energy, and the fact that the intrinsic energy has infinite value if the electron as an exact point is admitted. J. J. S.

APPARATUS AND INSTRUMENTS.

2053. Space-Charge Manometer for the Electrometric Measurement of High Vacua. W. Molthan. *Zeits. f. techn. Physik*, 11. 12. *pp.* 522–529, 1930.—A tube attached to the evacuated system contains four conducting elements, of which one is a filament emitting electrons, two are field-regulators, and the fourth is an electrode, the positive charge of which (derived from the space-charge) is a measure of the space-charge and therefore of the gas pressure. The fourth electrode is connected to the anodes of two triodes in parallel, the filament currents and grid potentials of which are so adjusted that the system has a linear $v_a - i_a$ characteristic for a range of v_a from $0{\cdot}5 - 5{\cdot}0$ volts. The anodes in turn are connected to a single-fibre electrometer of Lutz' type. Calibration curves show a linear relation between ionisation current and pressure of the gas, the lower limit of measurement being in the region of 10^{-10} mm. Hg, as compared with the limiting pressure of 10^{-6} mm. Hg measurable with an ordinary ionisation manometer operating directly upon a sensitive galvanometer. L. V. C.

2054. Optical Registration of Small E.M.F.s. K. Fill. *Zeits. f. Instrumentenk.* 51. *pp.* 39–44, *Jan.*, 1931.—A pointer galvanometer, with silk suspension, is employed, having a plane mirror attached above the pointer. Light from an electric lamp passes through a vertical slit and a lens, falls on the mirror, and is reflected so as to form an image of the slit on the photographic paper on which the record is made. This paper is fixed to the concave cylindrical surface of a slider, which can be moved vertically at different speeds by means of different trains of wheels driven by a motor. The axis of the cylindrical surface coincides with the suspension thread of the galvanometer, and the angular deflections of the light are double those of the pointer. In front of the paper is a concave cylindrical screen, with a horizontal slit, so that at any instant a small spot of light falls on the paper and records the deflection. Curves are reproduced, one of which registers an operation which took over two hours to complete. In another the slider moved very much slower, and the registration went on for twelve hours. A device is described by means of which longer periods of registration can be obtained. H. N. A.

2055. Portable D.C. or A.C. Spark Chronograph. C. N. Hickman. *Frank. Inst., J.* 211. *pp.* 59–65, *Jan.*, 1931.—The chronograph of the spark type, described in this paper, is designed to work on either a.c. or d.c., and on any voltage from 50 to 250. The instrument, as set out, is capable of recording six events, but can be adapted to a higher number. The paper gives a detailed specification of the instrument and the technique to be employed in its use. S. G. B.

2056. Measurement of the Voltage Operating a Self-Rectifying X-Ray Tube. C. V. Kent. *Rev. Sci. Instruments*, 2. *pp.* 44–46, *Jan.*, 1931.—The normal sphere gap across an X-ray tube does not measure the kilovoltage during the " active " half cycle, but rather the usually higher inverse voltage. A rectifying valve in the spark gap circuit can be used to suppress the inverse voltage, but this involves a considerable amount of subsidiary apparatus. It is suggested that the partial rectifying properties of a point-plane spark gap avoids this difficulty, and experimental evidence is given in support of this. G. E. B.

2057. Autographic Apparatus for Determining Inflection Points in Magnetic Susceptibility Curves. J. L. Haughton. *Journ. Sci. Instruments*, 8. *pp.* 7–14, *Jan.*, 1931.—A description of a modification of the magnetic susceptibility-temperature apparatus used in the Metallurgical Department of the National Physical Laboratory for the purpose of enabling autographic records to be taken. An alternating current from a valve oscillator is supplied to the magnetising coil of the apparatus, and the output from the search coil, amplified and rectified by triode valves and a Westinghouse rectifier, is registered on a thread recorder, together with the temperature of the specimen under examination. AUTHOR.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

2058. Absorption of Radiation from Different Sources by Water and by Body Tissue. W. E. Forsythe and F. L. Christison. *J.O.S.A.* 20. *pp.* 693–700, *Dec.*, 1930.—The paper considers some problems of the penetration of radiations from therapeutic sources. It is shown that almost all of the radiation that penetrates the surface from a low temperature source will be absorbed in a very thin outer layer of the body, while a considerable portion of the radiation from high temperature sources may penetrate deep into the body tissues. The transmission in water from 2000–24,000 Å. is considered and compared with Cartwright's data on the human cheek. It is pointed out that a very large percentage of the energy transmitted by the first 1 mm. is transmitted through the second as only the relatively penetrating wave-lengths pass even through 1 mm. of tissues. With respect to the absorption of energy at a given depth, the optimum radiation is that for which $1/e$ of the incident radiation reaches the desired depth. There is not much difference between the absorption by the body tissues of the radiations from the sun and high-temperature tungsten lamps. For a carbon heater at 2150 K.°, 15 % of the energy penetrates 1 mm. and 1 %, 1 cm. For a tungsten lamp 30 % passes 1 mm. = 2 % the first cm. It is desirable for therapeutic purposes to filter out the rays absorbed in the first mm., since it is these rays which cause the uncomfortable heating to the patient while contributing little to the energy reaching a given depth of say 1 cm. W. V. M.

2059. Electroscope Arrangement for Detection of Lost Radium. A. S. Eve and J. Katzman. *Journ. Sci. Instruments*, 8. *pp*. 20–21, *Jan*., 1931.—In searching for lost radium capsules a vertical microscope and inclined mirror are more convenient than a horizontal microscope when viewing the gold-leaf electroscope. The upper part of the insulated leaf system may be either closed or exposed to the outer air, in the latter case drawing many ions from a large region due to the radium. A single observation by the latter method will detect the presence of 1 mg. of radium in a closed room 30 × 30 feet. AUTHORS.

2060. Ultra-Violet Radiation from the Sunlight (Type S1) Lamp. A. H. Taylor. *J.O.S.A.* 21. *pp*. 20–29, *Jan*., 1931.—The Sunlight S1 lamp combines a spiral tungsten filament and a mercury arc enclosed in a bulb transparent to ultra-violet light and to visible light. Measurements show a good emission to some 3000 Å. with a distinct falling off of intensity to wave-lengths below 2800 Å., while on the long-wave side the intensity is sensibly constant from about 3500 Å. to at least 7600 Å. The mercury line 2537 Å. is almost completely absent, due, apparently, to absorption in the mercury vapour in the lamp. G. E. B.

2061. New Method for the Production of Electro-Cardiographs. H. Gabler. *Zeits. f. Instrumentenk*. 51. *pp*. 29–36, *Jan*., 1931.—The majority of present-day electro-cardiographs are based on current, and not voltage, measurement. In 1926 the author and others suggested the use of voltage-measuring instruments. The voltage measurement method is here considered from quantitative aspects. The construction of such instruments, which differ considerably from current-measuring instruments, is discussed. It is shown that an apparatus dependent on voltage measurement allows the production of electro-cardiographs which can give a true representation of the amplitude and frequency of the electrical variations of the heart. Thermionic valve design to fulfil maximal requirements is discussed mathematically. The combination of the valve amplification method, with the use of the compensation method of measurement of the voltage changes, allows the dual advantage of the use of a high-voltage amplification with a measuring instrument of high sensitivity (Reiter string galvanometer). The amplitudes of the electro-cardiograph curves so obtained are a multiple of the amplitudes of the curves of current-type apparatus as now used. This is illustrated by cardiograms taken by the two methods. The apparatus is shown schematically and in appearance. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

2062. Rigidity of Adsorbed Films. D. Talmud, S. Suchowolskaja and N. Lubman. *Zeits. f. phys. Chem.* 151. *Abt. A.* 5–6. *pp.* 401–412, *Dec.*, 1930.—The rigidity of surface films of palmitic, oleic, heptoic and octoic acids, cetyl alcohol, ethyl oleate, aniline and saponin on water at various concentrations has been measured. It is found that as the concentration of the capillary active substance is increased, the rigidity increases to a maximum and then decreases. It is pointed out that at low surface concentrations the molecules in the adsorbed film are lying flat and are therefore hydrated only to a slight extent. Hydration is also slight in closely-packed films when the molecules are vertical. In between these two extremes there is a position of maximum hydration, and it is suggested that at this stage the film possesses maximum rigidity. The relation between the rigidity of the adsorption film and the stability of air bubbles is discussed. F. J. W.

2063. Gravimetric Estimation of Gas-Films Adsorbed to Metal Surfaces. I. Strohhäcker. *Zeits. f. Physik,* 64. 3–4. *pp.* 248–261, 1930.—By means of an ultra-balance of Holtz' type (made by Bunge of Hamburg) mounted *in vacuo* and sensitive to $0 \cdot 26 \times 10^{-6}$ gm., the adsorption of dry air at 735 mm. Hg and 18° C. to a suspended sample of gold foil (weight $4 \cdot 123$ gm., area 762 sq. cm. and thickness $5 \cdot 6 \times 10^{-3}$ mm.) is measured directly, and amounts to $(3 \cdot 51 \pm 0 \cdot 1) \times 10^{-5}$ gm. The apparatus is described in detail, with special attention to thermal insulation, protection from vibration, elimination of electrostatic influences and of convection currents in the air, and manipulation (by electromagnetic devices) of the balance-riders. The specimen of foil is repeatedly heated to 750° C. *in vacuo* by an induction furnace, the balance being read meanwhile, and reaches a steady minimum weight in 40 hrs. When air is let in, a new equilibrium ensues in 30 hrs. The rate of adsorption is slow compared with adsorption on porous bodies (*e.g.*, charcoal), but is too fast for the effect to be due to diffusion; the slow rate is to be attributed, following Langmuir, to the low residual fields round the Au atoms, resulting in a large percentage of elastic impacts by air molecules. The quantity of air adsorbed corresponds closely to a unimolecular layer, assuming rectangular packing; if the packing is close hexagonal, 25 % of the area is available to accommodate thermal vibrations of the air molecules. L. V. C.

2064. Sorption of Carbon Tetrachloride at Low Pressures by Activated Charcoals. Part IV. A. J. Allmand and A. Puttick. *Roy. Soc., Proc.* 130. *pp.* 197–209, *Dec.*, 1930.—Further evidence of the increase in the initial adsorptive power of charcoal after degassing at high temperatures has been obtained; the data indicate that the effect is greater than had been previously supposed [see Abstract 1015 (1931)]. The view that this initial increase was due to the removal of oxygen and not to increase in the area of the charcoal has been confirmed. This adsorbed oxygen can be removed in practice by charging the charcoal with CCl_4 at 25° and a pressure of 1 mm. Further evidence of the discontinuous nature of the adsorption isothermals has been obtained. F. J. W.

2065. Sorption of Water Vapour at Low Pressure by Activated Charcoals. Part I. A. J. Allmand and R. B. King. *Roy. Soc., Proc.* 130. *pp.* 210–217, *Dec.*, 1930.—The adsorption of water vapour on charcoal has been studied at 25° C. and over the pressure range 10^{-1}–10^{-3} mm. The adsorptive power of the charcoal gradually increased as the last traces of adsorbed O_2 and CO_2 were removed from it. This removal could be accomplished by charging the charcoal with water vapour, but apparently water vapour is not so effective in this respect as CCl_4 [see preceding Abstract]. The final isothermals obtained were reversible. The heat of adsorption decreases as the amount adsorbed is increased to a value not very different from the latent heat of condensation of water vapour. F. J. W.

2066. Poisoning Effect of Water Vapour on Adsorption of Carbon Dioxide by Manganese Dioxide. H. W. Foote and J. K. Dixon. *Am. Chem. Soc., J.* 53. *pp.* 55–58, *Jan.*, 1931.—The adsorption isotherms at 25° of carbon dioxide on manganese dioxide with and without adsorbed water have been determined. The adsorption is reversible. Water reduces the adsorption markedly. The results indicate the presence of " active adsorption patches " on the oxide surface since the first portion of water adsorbed results in the greatest lowering of the carbon dioxide adsorbed. The corresponding behaviour of carbon monoxide toward manganese dioxide with and without adsorbed water is more complicated. Adsorption is highly irreversible, but the presence of adsorbed water causes the same qualitative effect as it does with carbon dioxide. AUTHORS.

2067. Specific Properties of Molecular Surface Fields. Structure of Active Carbon and the Inversion Effect of Adsorption and the Heat of Wetting. B. Iliin and J. Simanow. *Zeits. f. Physik*, 66. 9–10. *pp.* 613–618, 1930.—Two types of active charcoal have been studied. On the one, a hydrophobic charcoal, the adsorption of fatty acids from their aqueous solution follows Traube's rule, and the heat of wetting of an homologous series of alcohols increased as the molecular weight increased. On the other, a quasi-hydrophilic charcoal, the phenomena were exactly reversed. Further, Debye photographs of the charcoals revealed no differences in their structures. It is therefore suggested that the above inversion effects cannot be ascribed to differences in the molecular surface fields. F. J. W.

2068. Adsorption Theories of Frenkel and Hückel. A. Ganguli. *Zeits. f. Physik*, 66. 9–10. *pp.* 704–707, 1930.—It is pointed out that the adsorption isotherms of Frenkel and Hückel are formally identical with Langmuir's. F. J. W.

2069. Theory of Concentrated Solutions. M. Hoeppener and A. v. Antropoff. *Zeits. f. phys. Chem.* 152. *Abt. A.* 1–2. *pp.* 95–109, *Jan.*, 1931.—Vapour pressures and densities and the compositions of the liquid and vapour phases for benzene and carbon tetrachloride and their mixtures have been determined at 15°. The deviations of the saturated vapours from the ideal gas laws, calculated from the vapour densities, reach 3·5 %. The partial vapour pressures show that, for all compositions of the phases, Raoult's law for the vapour pressures of solutions holds with approximately the same accuracy as the ideal gas laws for saturated vapours. From this it follows that, in Henry's law for the dependence of the solubility of gases in liquids on the pressure, and in the application of Nernst's distribution law to a liquid and a vapour phase, the contents of the liquid solutions are to be given in molecular fractions. In so far as data are available, the same rules hold for other systems. T. H. P.

2070. Theories of the Soret Effect. G. S. Hartley. *Faraday Soc., Trans.* 27. *pp.* 1–10, *Jan.*, 1931.—Explanations of the migration of a solute to the colder parts of a solution are discussed. The theories of (*a*) van't Hoff, (*b*) Wereide, (*c*) Porter, and (*d*) Chapman are shown to be inadequate, and the hypothesis of constant " fugacity " of the solute at all points is also rejected. Treatment solely by ordinary thermodynamic functions appears to be insufficient; whereas Eastman, who relates the Soret effect in electrolytes to the action of electrolytic thermocouples, by the use of novel thermodynamic functions, has produced a more satisfactory theory. Although this theory is of rather limited applicability, it is corroborated by the author's more general theoretical investigation. J. P. A.

2071. Diffusion and Distribution in a Solvent of Graded Composition. G. S. Hartley. *Faraday Soc., Trans.* 27. *pp.* 10–29, 1931.—The distribution of a molecular solute in a solvent which already contains a second solute with a gradient of concentration is investigated experimentally. Acetone is employed as diffusing agent, and one of a number of substances as second solute. No evidence is obtained that the distribution of the first solute is influenced by forces other than those governing solubility and the propelling effect of the diffusing components. It appears that factors leading to increase of diffusion velocity tend to decrease solubility. J. P. A.

2072. Surface Potential of Unimolecular Films of Long Chain Fatty Acids. Part I. Experimental Method. Part II. Evaluation of Electric Moments. Part III. Potentials of Solid, Liquid Condensed and Double Layer Films. J. H. Schulman and E. K. Rideal. *Roy. Soc., Proc.* 130. *pp.* 259–294, *Jan.* 1, 1931.—Part I. The change in surface potential $\Delta V (= 4\pi n\mu$, where n is the number of mols./cm.^{2}, and μ the effective electric moment) at a $0 \cdot 01N$ hydrochloric acid-air surface due to a unimolecular film of myristic acid has been measured. When the film is spread by surface solution of a crystal the ΔV/time curve shows an arrest at 150–160 mV. With a film spread by a solution in petrol ether the ΔV/area curve shows arrests at (*a*) 39·5, (*b*) 53·5, (*c*) 88, and (less defined) 26–30 Å.^{2}; (*a*) corresponds to the transition, condensed to expanded film, (*b*) to that from expanded to vaporous. Hysteresis is marked for 88–100, and 30–40 Å.^{2}, and a well-marked metastable curve is obtainable on rapid compression to areas below 40 Å.^{2} Part II. The value of μ for a molecule of myristic acid in the expanded state is $2 \cdot 29 \times 10^{-19}$ e.s.u. The true value, $\bar{\mu}$, as obtained from the $\Delta V/n$ curve, is $2 \cdot 5 \times 10^{-19}$, the lower value including the effect of an ionic double layer in the electrolyte beneath the film. In the liquid condensed state (mesophase) $\bar{\mu}$ is constant ($1 \cdot 56 \times 10^{-19}$), increasing for both the solid condensed and expanded states, for which latter it is constant at $2 \cdot 5 \times 10^{-19}$. A new phase, the pre-homalic, appears in the transition from the liquid or expanded to the vapour state. Similar results are obtained with palmitic and pentadecylic acids. Part III. The contribution of the ionic double layer (ΔV_u) to the measured surface potential, μ, is deduced for palmitic acid from the equation $\Delta V = 4\pi n\bar{\mu} + V_u$, $\bar{\mu}$ for the liquid condensed state being $1 \cdot 59 \times 10^{-19}$, and independent of the acidity of the substrate.

Similar results are obtained with a film in the solid condensed state for which $\bar{\mu}$ is $3\cdot 18 \times 10^{-19}$. Borate and citrate ions (as buffers) have a marked effect. C. A. S.

2073. Ultramicroscopic Structure of Monomolecular Soap Films. C. Spierer. *Kolloid Zeits.* 54. *pp.* 17–21, *Jan.*, 1931.—Continues the work of Perrin, who using an ordinary microscope has shown that the thinnest soap films have a lamellar, stratified structure, with lamellæ $4\cdot 5\,\mu\mu$ thick, of the same order of magnitude as large chemical molecules. The author has investigated the structure of these lamellæ with the ultramicroscope. The films were horizontal, and the top layer was found to be built up, after a short time, of tiny plates 2 to $5\,\mu$ long, $0\cdot 25$ to $0\cdot 5\,\mu$ wide, and a few millionths of 1 mm. thick; these were arranged side by side, and very close together. During the very short time which elapsed before the gelification of the whole surface, as long as there were still fluid spaces between the successively forming lamellæ, the objective was focussed on the deeper layers. By using glycerine to hinder the gelification, it has been possible to settle the structure of three of the lamellæ, the upper and lower exterior layers, and one between them. The middle layer is formed of closely packed micellæ of micrococcus form, and the lower exterior surface has also a grained structure, but the grains are finer than in the middle layer. A very interesting account is given of the way in which the film thins at a given point, first the exterior layers, and one by one the others, disappearing, causing the thickness to diminish step by step from the circumference of a circular or elliptical patch towards a point in the interior. A very fascinating investigation. H. N. A.

2074. Variation of Number of Particles in the Evolution of a Colloidal Solution. Application to Blood Serum. A. Boutaric. *Comptes Rendus*, 191. *pp.* 1332–1334, *Dec.* 22, 1930.—The effect of heating blood serum on the number of particles in suspension is deduced from observations of viscosity and of the coefficient of absorption, or optical density, which is given by Rayleigh's expression:

$$h = \mathrm{AN}v^2(n^2 - n_0^2)(n^2 + 2n_0^2),$$

where h is the optical density, N the number of particles in unit volume, v their volume, n the index of the material of which they are constituted and n_0 the index of the fluid in which they are suspended, and A a constant dependent on the wave-length. From these observations it is found that the number of particles in the serum does not vary in the course of the transformations produced by heating. The molecules of serum swell through fixation of water without any variation in their number.

A. J. M.

2075. Adsorption and Protection Phenomena in Complex Colloidal Media. C. Marie and N. Marinesco. *Comptes Rendus*, 192. *pp.* 92–94, *Jan.* 12, 1931.—It is found necessary to separate protection from association phenomena in a complex colloidal medium. The protective colloid is in reality a very electronically deformable substance (*e.g.*, all metallic suspensions), which favours the adsorption of permanent dipoles, thus enclosing the particles and isolating them from the dispersing medium. Dielectric analysis enables the *a priori* choice of a protective colloid in the sense that it must also be as polarised as possible in the permanent state. Examples are discussed of aqueous solutions of gelatin, glycocoll and leucine, and of aqueous suspensions of animal charcoal. H. H. Ho.

2076. Acceleration Produced by Light in the Flocculation of Colloidal Solutions in a Fluorescent Medium. A. Boutaric and J. Bouchard. *Comptes Rendus,* 192. *pp.* 95–97, *Jan.* 12, 1931.—It is known that the addition of fluorescent matter to cultures helps the destruction of bacteria by light. It has been found in this work that fluorescent bodies have an accelerating effect on the flocculation of colloidal solutions produced by electrolytes. The dosage of electrolyte necessary to produce flocculation is also reduced considerably by the presence of fluorescent matter and the action of light together. Cases giving negative results were found to be those in which the electrolyte inhibits the fluorescence. Colouring matter which is not fluorescent has no such accelerating effect. J. E.

2077. Photometric Measurement of Concentration and Dispersity in Colloidal Solutions. Part I. Measurement of Light Weakening. T. Teorell. *Kolloid Zeits.* 53. *pp.* 322–338, *Dec.,* 1930.—The results of experiments here described, in conjunction with those published by others, are used to show how a number of factors may influence the diminution in light intensity and the scattering produced by colloidal, turbid solutions. As regards the effect of the thickness of the layer, Lambert's law holds within wide limits and the statements of Soós and of Galvez that the constant of light-weakening varies discontinuously with the thickness of the layer could not be confirmed. For the variation with concentration, Beer's law holds up to quite high concentrations, but as these are increased still further, a diminution of the weakening constant per concentration unit becomes apparent; this effect may depend on multiple scattering, but other explanations are possible. For variation with the wave-length, Rayleigh's $1/\lambda^4$ law is followed only by extremely finely dispersed sols of small extinction, the exponent being usually less than 4. With mastic sols of varying dispersity but constant concentration, the influence of the degree of dispersion is, in general, in accordance with theory; with medium-disperse sols, a maximum of weakening appears. Hydrophile colloids do not follow Beer's law, probably owing to variation of the degree of hydration with the concentration. [See also following Abstract.] T. H. P.

2078. Photometric Measurement of Concentration and Dispersity in Colloidal Solutions. Part II. T. Teorell. *Kolloid Zeits.* 54. *pp.* 58–66, *Jan.,* 1931.—The degree of dispersity of a sol, especially a feebly extinguished sol, may be defined by a dispersity quotient, representing the ratio between the absorption coefficients for light of short and long wave-lengths. This quotient has higher values for highly-disperse than for coarsely-disperse sols, and theoretical and experimental results show that, for sols of medium dispersion, the value of the quotient varies approximately linearly with the magnitude of the particles. The means thus furnished of determining the absolute size of the particles is applied to mastic and ferric hydroxide sols before and after flocculation by electrolytes. The curve showing the relation of the coagulation of mastic by calcium chloride to the time is paraboloidal, and may be represented by a formula of exponential type, which is compared with Jablczynski's coagulation formula. The ageing of a mastic sol acts, as regards light absorption, similarly to coagulation. [See preceding Abstract.] T. H. P.

2079. Spectrophotometric Investigations on the Action of Light on Nuclear Silver Sol. A. Galecki and R. Spychalski. *Kolloid Zeits.* 53. *pp.* 338–352, *Dec.*, 1930.—The decolorisation of silver hydrosols prepared by the nuclear method under the influence of ultra-violet light probably consists of a process of oxidation of the colloidal silver by the action of the hydrogen peroxide formed under the influence of the ultra-violet rays in the dispersion medium (water). Quantitative spectrophotometric investigations show that the reaction is of the first order; the temperature coefficient is low, but still somewhat greater than unity. T. H. P.

2080. Dispersoid Synthesis of Gold by Means of Alkaline Formaldehyde Solutions. Part II. P. P. v. Weimarn. *Kolloid Zeits.* 53. *pp.* 352–370, *Dec.*, 1930.—In continuation of his earlier paper [see Abstract 822 (1930)], the author summarises work dealing with the influence of the purity of the reagents and water, the material, form and mode of heating of the vessel, on the resultant solution, the causes of the stability of the dispersoid gold solutions thus formed, etc. T. H. P.

2081. Influence of Volume in Swelling. Dorothy J. Lloyd. *Kolloid Zeits.* 54. *pp.* 46–49, *Jan.*, 1931.—The swelling of purified gelatin in alkaline solutions (osmotic swelling) is independent of the volume of the solution, provided that the temperature is sufficiently low (0°) to prevent hydrolytic decomposition. In salt solutions the swelling of gelatin is independent of the volume of the solution over wide ranges of temperature and salt concentration. This is the case whether the swelling reaches an equilibrium or finally leads to solution. [See also Abstract 826 (1930).] T. H. P.

2082. Preparation of Colloids by the Condensation Method of Molecular Rays. N. Tomaschewsky. *Kolloid Zeits.* 54. *pp.* 79–81, *Jan.*, 1931.—The following colloids have been prepared and investigated: Hg in water, Cd in ether, Se in water, Na in ether, benzene, xylene and hexane, K in ether and xylene, Rb and Cs in ether. In the case of the alkali metals, their stability is found to be greater than that found by Schalnikoff and Roginsky, and their extraordinarily great stability in ether is in excellent agreement with Ostwald's theory on the effect of the dipole moment of the solvent on the stability of the colloid. The improvement in stability by the condensation method of molecular rays, details of which are given, constitutes a definite advance in technique, although the method is still too coarse for finality to be concluded. The absorption spectra and the colloidal concentration are thoroughly investigated, and it appears that the particle dimensions are greater than the molecular. H. H. Ho.

2083. Effect of H.F. Oscillations on Metallurgical Operations. G. Mahoux. *Comptes Rendus*, 191. *pp.* 1328–1332, *Dec.* 22, 1930.—When a steel specimen is subjected to h.f. oscillations, by electromagnetic or mechanical means, during treatment, it is found that the process of "nitriding" in ammonia at 500° C., the diffusion of chromium at 530° C. from an electrolytically deposited layer into the underlying steel, and decarbonisation of steel in air at 530° C. are accelerated to a remarkable degree, and in the first case the mechanical properties of the material at the centre of the test-pieces are greatly improved. **L. Guillet** confirms these results, adding that under the influence of h.f. oscillations certain reactions and diffusion processes occur at a temperature lower than that necessary in the absence of the oscillations, and that similar phenomena are observed in many other alloys. It is supposed that the vibrations have the effect of overcoming passive resistances. A. J. M.

2084. Mechanism of the Hardening of Steel. G. Kurdjumow and G. Sachs. *Zeits. f. Physik,* 64. 5–6. *pp.* 325–343, 1930.—Single crystals of austenite were converted partially into martensite by water quenching. The structure of the samples so obtained has been studied before and after annealing at various temperatures by taking X-ray photographs. The particles of the tetragonal martensite phase and of α-iron were found to be arranged regularly. The nature of the changes occurring during the hardening of steel is discussed. F. J. W.

2085. Region of Brittleness of Iron at Low Temperatures. F. Sauerwald, B. Schmidt, and G. Krämer. *Zeits. f. Physik,* 67. 3–4. *pp.* 179–183, *Jan.* 21, 1931.—A continuation of previous investigations [see Abstract 2956 (1930)]. An accurate delimitation was made of the region of brittleness of iron with technical material and single crystals. With technical soft iron a sharp boundary of the brittleness was found at −155° C. With two crystal systems of a special soft iron the limit of the brittleness can come to between −90° and −98° C. The brittle fracture occurs in general as internal crystalline; in the region from −144° to −154° C., also as grain boundary fracture. J. J. S.

2086. Production of Metal Single Crystals. L. Graf. *Zeits. f. Physik,* 67. 5–6. *pp.* 388–416, *Jan.* 31, 1931.—A new method is described for the production of metal single crystals. The method involves the use of a h.f. oven operated on a frequency of 8000 cycles, the inner chamber being evacuated. Besides copper, silver and gold crystals, mixed crystals of gold-silver, gold-copper and palladium-copper have been obtained, and also crystals of nickel. A simple method for determining the direction of growth is given. The dependence of the direction of growth on the experimental conditions, choice of temperature and nature of crucible, was investigated. A new procedure for obtaining single crystals of any desired orientation is described; it consists in the use of embryo or seed crystals, which are arranged in the bottom of the crucible and impress their orientation on the crystal formed from the material melted above them. A. W.

2087. Texture of Metals after Deformation. W. Boas and E. Schmid. *Zeits. f. techn. Physik,* 12. 2. *pp.* 71–75, 1931.—The texture formed by compression and extension of metals in the polycrystalline state can be explained if it is assumed that to each grain there are at least three systems of translation. F. J. W.

2088. Relation Between Physical Changes Due to Cold Work and Mixed Crystal Formation, with Particular Reference to Tungsten. C. Agte and K. Becker. *Phys. Zeits.* 32. *pp.* 65–80, *Jan.* 15, 1931.—A summarising paper. Cold working of a metal produces changes in many physical properties similar to those obtained by the addition to the metal of a substance forming mixed crystals with it. It is suggested that this is due to the fact that in both cases distortion of the metallic lattice takes place. The cases in which the similarity does not exist are discussed. It is pointed out that the changes in physical properties brought about by the orientation of the crystal grains by cold work are not caused by mixed crystal formation. F. J. W.

2089. X-Ray Study of the Lattice Structure of the ϵ-Phase in the Cu-Sn System. J. O. Linde. *Ann. d. Physik,* 8. 1. *pp.* 124–128, *Jan.* 26, 1931.—The atoms are shown to be arranged regularly in the lattice of the ϵ-phase of the copper-tin system. It is pointed out that this result does not permit a simple arrangement of the atoms to be built up which possesses hexagonal symmetry. F. J. W.

2090. Allotropy of Rhodium and X-Ray Analysis of Heated Wires. F. M. Jaeger and J. E. Zanstra. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 15–32, 1931.—The paper is an account of X-ray analysis of wires of palladium, rhodium and platinum under various conditions of temperature and heat treatment. There are two forms of rhodium, both cubic, but with different lengths of side, and the two forms usually coexist. In studying the influence of heat treatment on the three metals, complications were found, of which no explanation is considered possible without further work. For details, the paper itself should be consulted. J. H. A.

2091. Diffusion in Cast Bismuth-Antimony Alloys. G. Masing and Hildegard Overlach. *Wiss. Veröff. a. d. Siemens-Konzern,* 9. 2. *pp.* 331–338, 1930.—Alloys of Bi and Sb, on reheating at 260–300°, show marked reduction in density; thus on reheating for 72 hours at 300° one containing 25 % (by weight) of Sb its density fell from 8·822 to 7·254, and the whole became full of small cavities, more especially the inner portions. This is not due to evolution of gas. Microscopic examination showed in the unheated samples typical zone structure, which on reheating the alloy becomes uniformly crystalline. It is concluded that the effect is due to diffusion at differential rates, the Bi, which had concentrated along the zone boundaries, diffusing into the Sb more quickly than the Sb into the Bi. C. A. S.

2092. Potential of Passive Iron. A. Travers and J. Aubert. *Comptes Rendus,* 192. *pp.* 161–163, *Jan.* 19, 1931.—Measurements were made on the potential of iron rendered passive by various methods. The potential of active iron was determined in a solution of sodium sulphate, through which a current of pure nitrogen was passed. The constant voltage of – 0·730 was attained in seven hours. Samples of iron were rendered passive by OH ions, by oxidising agents, chromate, iodate, periodate, and permanganate of potassium, also by coating with oxide of iron, and by air or oxygen. The results of potential measurements showed that the iron was only passive in a limited sense, and the results did not tend to support the oxide layer as a cause of passivity. F. J. B.

2093. Passive State of Chromium. E. Müller and O. Essin. *Zeits. f. Elektrochem.* 36. *pp.* 963–972, *Dec.,* 1930.—The passive state of electrolytically-prepared chromium was investigated. It was found that when chromium was precipitated electrolytically from aqueous solutions of chromic acid, no reduction of the chromic acid took place at the kathode. Gaseous hydrogen was the sole product. Electrolytic chromium was found to be passive at 0° C. in normal solutions of HCl, HBr, HF, H_2SO_4, $HClO_4$, H_3PO_4 and HNO_3. When chromium was kathodically polarised in a non-activating acid, the activity of the metal was restored. The activity was restored by heating the metal in the four first-mentioned acids, each acid showing a definite temperature of activation. The activating action of HCl was reduced or stopped by the presence of other anions. F. J. B.

2094. Reduction in Velocity of Corrosion by Colloids. W. Beck and F. v. Hessert. *Zeits. f. Elektrochem.* 37. *pp.* 11–20, *Jan.*, 1931.—The reduction of the velocity of corrosion of iron in water or solutions of strong acids by the addition of hydrophile colloids is confirmed. The magnitude of the decrease of the reaction velocity depends upon the nature and concentration of the added material. The adsorption theory is not satisfactory as an explanation of the observed facts. It is considered that the reduction of the velocity of corrosion is a consequence of the formation of a colloid sheath on the surface of the solid phase. Such an explanation is supported by the alteration of the corrosion velocity by stirring or shaking. F. J. B.

2095. Cadmium as Protection Against Rust. B. Planner. *Zeits. f. Elektrochem.* 37. *pp.* 33–49, *Jan.*, 1931.—The use of cadmium as a protection against rusting of iron is discussed from a general point of view. The various methods of coating objects with cadmium are considered and their defects or advantages discussed. The electrodeposition of cadmium from solutions of different electrolytes, with and without the addition of colloids, is studied. A series of pieces of cold rolled iron strips were coated with cadmium by electrolysis of a solution of cadmium cyanide in potassium cyanide. The character of the deposits was examined microscopically. In cyanide baths the best deposits were obtained at current densities of 50 to 100 amp. and at temperatures of 40° to 60° C. In acid baths, silicofluoric acid, with the addition of liquorice extract, perchloric acid, and phenolsulphonic acid with the addition of colloids, current densities of 100 to 150 amp. per sq. m. and temperatures of about 40° C. gave the best deposits. The ability of the various deposits to protect the iron against corrosion was tested by exposing the test pieces to various atmospheres and to salt spray. It is concluded that cadmium is an efficient protection for iron. F. J. B.

2096. Velocity of Solution of Metals in Acids. W. Guertler and B. Blumenthal. *Zeits. f. phys. Chem.* 152. *Abt. A.* 3–4. *pp.* 197–234, *Jan.*, 1931.—The solution of iron, copper and nickel in $0\cdot1\,N$ HCl was investigated, and the conditions determined under which reproducible results for the solution of a single body could be obtained. The iron, copper and nickel were melted *in vacuo*. The iron and nickel were annealed at 1000° C. for 6 hours, the copper at 900° C. for the same length of time. The metals were then turned into small cylindrical test pieces, having 3 to 8 sq. cm. surface. The velocity of solution was determined by a method in which the resistance capacity was kept constant, so that the theory of local elements could be applied to the results. The hydrogen overvoltage present in the natural local elements during solution was capable of approximate calculation. As the solution progressed the overvoltage became smaller. The change of the hydrogen overvoltage indicated the progress and the increase of the velocity of solution. The theory of local elements is considered to hold for the case of the solution of zinc in hydrochloric acid. F. J. B.

2097. Heats of Combustion of Methane and Carbon Monoxide. F. D. Rossini. *Bureau of Standards, J. of Research*, 6. *pp.* 37–49, *Jan.*, 1931.—With the use of the calorimetric apparatus and procedure employed for determining the heat of formation of water [see Abstract 1418 (1931)], the heats of combustion of methane and carbon monoxide have been measured. The heat of combustion of CH_4 to form liquid H_2O and gaseous CO_2 is found to be 889,700 ± 300 international joules per mole at 30° C. and a constant pressure of 1 atmosphere, which is equivalent to 890,160 ± 300 international joules per mole at 25° C. and 1 atmosphere. The heat of combustion of CO to form CO_2 is found to be 282,925 ± 120 international joules per mole at 30° C. and a constant pressure of 1 atmosphere, which is equivalent to 282,890 ± 120 international joules per mole at 25° C. and 1 atmosphere. AUTHOR.

2098. Theory of Combustion of Colloidal Powders in a Closed Vessel. H. Muraour. *Comptes Rendus,* 192. *pp.* 227–229, *Jan.* 26, 1931.—The theory is that the powder burns because its temperature is raised to that of its decomposition by the shock of the gaseous molecules already given off, and that the temperature of the layer immediately in contact with the powder, and in which combustion is incomplete, is lower than that of explosion. The temperature rises with the more complete combustion at increased distance from the surface of the powder. At high pressures layers of gas parallel to such surface do not intermix, owing to their high density, but do so at lower pressures, thus increasing in this case the temperature of the layer at the surface of the powder. Hence the increased velocity of combustion at low densities of loading. Other deductions are drawn, and shown to be in accord with the author's experimental results. [See Abstracts 2963 (1930) and 1043 (1931).] C. A. S.

2099. Combustion of Inflammable Gases by Electric Sparks. J. D. Morgan. *Phil. Mag.* 11. *pp.* 158–163, *Jan.*, 1931.—It has previously been shown [see Abstract 1329 (1922)] that the ignition of a gas mixture by an electric spark is consistent with the hypothesis that ignition depends on the heating of a sufficient volume of the gas by conduction to a sufficient temperature. In the experiments now described a very weak mixture of coal-gas and air was used and a rapid succession of high-tension sparks was maintained without any appearance of burning in the gas, which was at atmospheric pressure and temperature. The results of these experiments show that under such conditions the amount of combustion, or combination of the constituents, which takes place in the mixture is proportional to the heat energy of the spark discharge when the gap width is kept constant, and is proportional over a wide range to the gap width when the heat energy of the discharge is kept constant, the results in general being consistent with the hypothesis that combustion, like ignition, depends upon the heating of the gas by conduction. A. W.

2100. Propagation of Flame in Electric Fields. Part I. Distortion of the Flame Surface. E. M. Guénault and R. V. Wheeler. *Chem. Soc., J. pp.* 195–199, *Jan.*, 1931.—When a flame spreads from the centre of a sphere, its normal symmetry is destroyed if it is exposed to an electric field. While the flame is between the plates of a charged condenser of low capacity and before it has actually touched the plates, it is wholly within the electric field and is most susceptible to influence by it. As soon as the flame surface, which conducts electricity, touches the plates, the system tends to discharge itself, and the field is almost entirely destroyed as long as any part of the flame surface touches the plates. Little or no change appears in the rate of growth of the flame in a direction transverse to the field. Longitudinally to the field the electrons move towards the positive plate, so that, in this direction, the field would cause electrons produced in the flame to move ahead of it with increased speed, and in the opposite direction it would retard them. The photographs obtained show, however, that the electric field did not stimulate the growth of the flame towards the positive plate. It seems that the movement of the flame surface may be mechanical, owing to the movement of the heavy positive ions dragging the flame surface with them, and not necessarily the result of a stimulus to chemical activity imparted by the electric field. T. H. P.

2101. Metastability of Matter and Its Significance for Calorimetric Standards. Part I. E. Cohen and H. Goedhart. *K. Akad. Amsterdam, Proc.* 34. 1. *pp.* 3–14, 1931. *In German.*—It is shown by very exact determinations of the solubility of salicylic acid that two forms are capable of existence at ordinary temperatures. The metastable form is capable of remaining in this state for long periods. The existence of these two forms is considered to account for the discrepancies between solubility determinations carried out by different observers. Owing to the metastable state persisting, preparations of salicylic acid which are used for standards for the calibration of a calorimeter must be regarded as indefinite and unreliable. The heat of combustion of the two forms present in the metastable mixture is subject to change, and it is considered desirable to determine how far the values for the heat of combustion of salicylic acid are influenced by the two forms. F. J. B.

2102. Chemical Effects of Kathode Rays. Part I. Decomposition of Ammonia. G. R. Gedye and T. E. Allibone. *Roy. Soc., Proc.* 130. *pp.* 346–366, *Jan.* 1, 1931.—A special form of Lenard discharge tube was employed, through a thin aluminium window of which a beam of electrons was passed through a second aluminium window into an evacuated reaction vessel, containing ammonia. A large Tesla transformer was used to work the discharge tube, which had the disadvantage that the a.c. was damped, and that the velocities of the electrons varied greatly. All measurements of the beam were made with Faraday cylinders and calorimeters placed outside the discharge tube. The volumes of permanent gas formed with different pressures in the reaction vessel were measured for different times of reaction, and when necessary these gases were analysed. The percentages of hydrogen and of nitrogen present varied with the initial pressure, and the excess of hydrogen obtained at low pressure was found to be due to the formation of hydrazine. Good agreement is obtained with Wourtzel's results for α-particles in the same reaction; the results agree qualitatively with those obtained in the silent discharge and in ultraviolet light. It is calculated that $1 \cdot 2$ molecules of ammonia are decomposed for each ion pair formed. H. N. A.

2103. Formation of Ammonia from its Elements in Electrical Discharges. M. Alsfeld and E. Wilhelmy. *Ann. d. Physik,* 8. 1. *pp.* 89–123, *Jan.* 26, 1931.—The formation of ammonia from nitrogen and hydrogen has been studied in the silent, Townsend, corona, glow and arc discharges. In the silent discharge the influence of the temperature of the walls of the discharge tube has been investigated. At ordinary temperatures the influence of temperature on the yield of ammonia is slight, but as the temperature rises to above 400° K. the yield of ammonia increases rapidly. The results can be explained if it assumed that the reaction giving rise to ammonia occurs at the wall. F. J. W.

2104. Attempt to Measure the Velocity of Dissociation of Nitrogen Tetroxide by the Method of Sound Waves. G. B. Kistiakowsky and W. T. Richards. *Am. Chem. Soc., J.* 52. *pp.* 4661–4671, *Dec.*, 1930.—It has been assumed that when compressions and rarefactions in sound waves succeed each other with sufficient rapidity, the dissociating gas will no longer be able to attain equilibrium. An increased velocity of sound with increasing frequency was therefore to be expected when a critical region of frequency is reached. After criticising the results of Olson and Teeter, Grüneisen and Goens, etc., the authors record their own work on nitrogen tetroxide. They used a magnetostriction oscillator of the type due to Pierce, for the production of a wide range of conditions. Full experimental details are given. The velocity of sound in nitrogen tetroxide was investigated from 10 to 80 kilo-cycles, and from 760 to 140 mm., and was found to be independent of the frequency. The minimum velocity constant calculated from these experiments is not far from the maximum possible velocity constant deduced from the kinetic theory of gases. The kinetic theory of reaction velocity is discussed in relation to this conclusion. S. G. B.

2105. Thermal Decomposition of Nitrogen Pentoxide at Low Pressures. J. H. Hodges and E. F. Linhorst. *Nat. Acad. Sci., Proc.* 17. *pp.* 28–33, *Jan.*, 1931.—The rate of thermal decomposition has been measured at 35° C. and at pressures between 0·12 mm. and 0·001 mm., and the reaction found to be unimolecular above 0·06 mm. partial pressure of N_2O_5. Below 0·06 mm. the specific reaction rate drops steadily with decreasing pressure, and below 0·004 mm. the reaction appears to be bimolecular. H. H. Ho.

2106. Molecular Attractive Forces and the Velocity of Chemical Reactions. C. C. Coffin and O. Maass. *Canad. J. of Research*, 3. *pp.* 526–539, *Dec.*, 1930.—The reactions between hydrogen chloride and α-, β-, and γ-butylene have been investigated in both the liquid and gaseous states. The effect of temperature and concentration of the reactants on the reaction velocities was studied and the reaction products were examined. In the liquid state the γ-isomer reacts rapidly, the α- much more slowly and the β- slowest of all. In the gaseous state at atmospheric pressure only γ-butylene shows a measurable reaction which is bimolecular and probably heterogeneous. The liquid reactions were found to be homogeneous. Where possible the freezing-point curves of the systems were determined in order to ascertain the extent of molecular compound formation. The results obtained bear out the conclusions arrived at from previous work on the effect of molecular attraction upon reaction velocity, and indicate the existence of a catalytic factor peculiar to the liquid state. Suggestions as to the mechanism of such a catalysis are offered. AUTHORS.

2107. Effect of Intensive Drying on Velocity of Gaseous Reactions. C. C. Coffin and O. Maass. *Canad. J. of Research*, 3. *pp.* 540–542, *Dec.*, 1930.—Ammonia and carbon dioxide were subjected to intensive drying, with subsequent inhibition of reaction when the gases mixed. Liquefaction of the non-reactive mixture resulted in immediate reaction taking place and the hypothesis is put forward that the " liquid condition " may be looked upon as a catalytic influence. AUTHORS.

2108. Variation of $\int pdt$ with Charge Density for Different Types of Powder. H. Muraour and G. Aunis. *Comptes Rendus*, 192. *pp*. 90–92, *Jan*. 12, 1931.—The general experimental method employed in this investigation is the same as that in a previous publication [see Abstract 1043 (1931)]. The powders used were mixtures of gun-cotton and nitroglycerin in three examples and nitrocellulose in a fourth experiment. The data obtained show that the inverse of $\int pdt$ for all the powders is practically a linear function of the inverse of the maximum pressure between 2500 and 300 kg. H. H. Ho.

2109. Electromotive Activation of Oxygen. A. B. Lamb and L. W. Elder, Jr. *Am. Chem. Soc., J*. 53. *pp*. 137–163, *Jan*., 1931.—The kinetics of the reaction between solutions of ferrous sulphate and gaseous oxygen are reinvestigated. Particular attention is paid to the accelerating effect of various secondary or accessory catalysts. An electrometric method is developed for following the progress of the oxidation, which is independent of the unknown activity coefficients of ferrous and ferric ions in these solutions. It is concluded that specific peroxides are responsible for the accelerating action. A peroxide-like substance was isolated in minute amount from aerated cocoanut charcoal. Cocoanut charcoal and platinum black were found to exert pronounced accelerating effects, and sodium pyrophosphate added to ferrous sulphate solutions increased the rate of oxidation about 1000 times. F. J. B.

2110. Photochemical Kinetics of Chlorine Detonating Gas (Oxygen-Free). M. Bodenstein and W. Unger. *Zeits. f. phys. Chem*. 11. *Abt. B*. 4. *pp*. 253–278, *Jan*., 1931.—An investigation of detonating mixtures of chlorine and hydrogen in the absence of oxygen shows the chain effect to be proportional to the concentration of chlorine atoms, the original assumption that the reaction ensues by diffusion to the wall with recombination there being untenable. Decomposition at the quartz-glass wall was found to produce silicon chloride, which subsequently participates in the reaction. When small amounts of oxygen are present, the reaction of this gas with hydrogen is found alongside the main effect. Apparent contradictions in previous investigations are explicable by side reactions with impurities. H. H. Ho.

2111. Calculation of Chemical, Electrical, and Gas-Mechanical Transformations of Matter, Energy and Form by Space Energetics. R. v. Dallwitz-Wegner. *Zeits. f. Elektrochem*. 37. *pp*. 25–33, *Jan*., 1931.—In continuation of previous work [see Abstract 3686 (1929)], the author gives a summary of communications published since 1919. The subjects considered comprise: cohesion pressure, fundamental formulæ of space energetics, space-energy chemical changes, inverse space-energy processes, processes occurring in the Daniell cell, mechanics of galvanism, contact electricity and thermoelectricity, connection of space-energy equations with the gas laws, efficiency, entropy, and the second fundamental law. T. H. P.

2112. Potential of the Cadmium Electrode. F. H. Getman. *J. Phys. Chem*. 35. *pp*. 588–595, *Jan*., 1931.—The measurement of the e.m.f. of the cell: Cd, $CdCl_2(m)$, Hg_2Cl_2, Hg, in which the cadmium electrodes were either single crystals or massive aggregates of the pure metal, showed that when the electrodes were single crystals of pure cadmium, constant and reproducible results were obtained. The potential of the single crystal electrode was higher than that of the polycrystalline form. The normal electrode potential of cadmium, calculated from the e.m.f. of cells with single crystal electrodes, was found to be 0·395 volt. F. J. B.

2113. Transport Numbers of Hydrogen Chloride in Ethyl Alcohol. J. W. Woolcock, H. Hartley and O. L. Hughes. *Phil. Mag.* 11. *pp.* 222–225, *Jan.*, 1931.—Measurements have been made of the e.m.f.s of cells containing hydrogen chloride in ethyl alcohol, with and without liquid junctions, and the most probable value for the transport number of the hydrogen ion at infinite dilution has been found to be 0·71 ± 0·01. AUTHORS.

2114. Electrokinetic Potentials. H. B. Bull and R. A. Gortner. *J. Phys. Chem.* 35. *pp.* 309–330, *Jan.*, 1931.—This paper deals with electrical phenomena at interfaces. Smoluchowski's equation for surface conductance has been modified by the appropriate substitutions, so that the equations have been obtained, one expressing the charge per unit area on the surface and the other taking into consideration the thickness of the double layer. The ζ-potential and surface conductance at a cellulose interface have been measured for aqueous solutions of KCl, NaCl, $MgCl_2$, $CaCl_2$, K_2CO_3, K_2SO_4, K_3PO_4 and $ThCl_4$. The physical significance of the results is discussed. The ζ-potential is found in general to decrease with increasing concentration of electrolytes in the aqueous phase, but may be accompanied by an actual increase in the charge on the particle, the decrease of ζ-potential being more nearly related to a decrease in the thickness of the double layer. The theoretical considerations of Gouy and the results of McClendon for KCl are confirmed for a series of electrolytes, *i.e.*, the thickness of the double layer is decreased with increasing salt concentrations. A new conception of the action of electrolytes in affecting the stability of a colloid is suggested, *i.e.*, that the salts do not reduce the electric charge on the particle to zero or even to a " critical threshold," but rather that there is a decrease in the thickness of the double layer which allows the particles to approach each other closely enough for adherence. With polyvalent ions, the charge itself may actually be decreased so as to approach zero. H. H. Ho.

2115. Potential Differences at Air-Liquid Interfaces. J. W. Williams and V. A. Vigfusson. *J. Phys. Chem.* 35. *pp.* 345–353, *Jan.*, 1931.—The potential differences have been measured in a vertical direction across the liquid-air interface, and are found to be absolutely dependent upon the composition of the surface layer of molecules limiting the liquid phase. The latter layer is definitely an adsorption layer whose composition may be determined more or less exactly by noting the changes in surface tension caused by dissolved substances according to the Gibbs' equation. Comparison of data shows that, except where specific interaction between the mercury surface and definite constituents of molecules is in question, there is good agreement between the conclusions which have to be drawn from the data in the two cases of polar and non-polar groups of substances. H. H. Ho.

2116. Electrocapillarity. Part III. J. A. V. Butler and C. Ockrent. *J. Phys. Chem.* 34. *pp.* 2841–2859, *Dec.*, 1930.—Continuing previous work [see Abstract 1061 (1931)], surface-tension measurements were made of solutions containing two surface active solutes at the solution-air interface. The solutions studied were ethyl alcohol in propyl alcohol, ethyl and propyl alcohols in water, propyl alcohol and phenol, propyl alcohol in water and phenol solutions. Electrocapillary curves were determined for solutions of phenol and caffein in M/2 sodium sulphate and for sodium cinnamate and sodium *o*-toluate in M/2 sodium sulphate. The results showed a good agreement with the surface tension lowering calculated from Langmuir's theory of adsorption, applied to the simultaneous adsorption of two solutes from solution, and the surface tension lowering produced in the presence of a surface active substance was calculated by aid of Szyszkowski's equation. F. J. B.

2117. Becquerel Electrocapillary Phenomenon. H. Freundlich and K. Söllner. *Zeits. f. phys. Chem.* 152. *Abt. A.* 3–4. *pp.* 313–314, *Jan.*, 1931.—The paper is a correction of a previous publication [see Abstract 1729 (1929)]. The precipitation of a metal by the Becquerel phenomenon requires that the decomposition potential shall have a positive value if the assumption is made that a circular current flows in the membrane of the precipitate, so that the current flows through the salt solution in one direction, and in another direction in the metallic conducting membrane. F. J. B.

2118. Observation of Cataphoresis in Nitrocellulose Solutions. E. A. Lantz and O. A. Pickett. *Indust. and Engin. Chem.* 22. *pp.* 1309–1311, *Dec.* 1, 1930.—Cataphoresis in nitrocellulose solutions in various solvents was observed by allowing a stream of the solution to issue from a burette between two metal plate electrodes. As the sol flowed through the dispersion medium the movement due to the electric field was photographically recorded. Many types of solvent were examined, and the effect was found to be the greatest for acetone and least for amyl acetate. Low viscosity types of nitrocellulose showed less charge than those prepared from high viscosity types, provided that the solvent and the concentrations were the same. F. J. B.

2119. Electrophoresis and the Diffuse Ionic Layer. M. Mooney. *J. Phys. Chem.* 35. *pp.* 331–344, *Jan.*, 1931.—The theory of the diffuse ionic layer and its influence on the electrophoresis of a sphere is outlined and a theoretical formula derived for the limiting slope of the mobility-curvature curve. Experimental data are included which are in rough agreement with theory as applied to dilate aqueous solutions. Formulæ are given for surface charge and surface conductivity, although the latter does not agree with the measured values. Various anomalous effects in cataphoresis suggest the existence of a plastic adsorbed layer which seems to have a profound effect on the electrokinetic potential in concentrated acid and neutral solutions. It is pointed out that the validity of the Debye-Hückel cataphoresis formula is limited to conditions in which the colloidal particle is much smaller than its diffuse ionic layer. H. H. Ho.

2120. Removal of Salts from Concentrated Solutions by Electro-osmosis. R. Hoffmann. *Wiss. Veröff. a. d. Siemens-Konzern,* 9. 2. *pp.* 339–351, 1930.—The changes which take place when a solution of sodium sulphate is subjected to electroosmosis are investigated. It is shown that for falling temperature or increasing current density the transport numbers decrease, denoting an increase of charge on the diaphragm. Addition of sugar had the effect of decreasing the transport numbers. The transport numbers at 20° and 60° C. decreased with the increase in current density. The results and methods are applied to the removal of salts from a solution of molasses. F. J. B.

2121. Electrodeposition of Cobalt-Nickel Alloys. Parts I and II. S. Glasstone and J. C. Speakman. *Faraday Soc., Trans.* 26. *pp.* 565–574, *Oct.,* 1930, *and* 27. *pp.* 29–35, *Jan.,* 1931.—Part I describes investigations of the compositions of the alloys deposited from well-buffered solutions of definite H-ion concentration containing various mixtures of cobalt and nickel sulphates at a series of current densities ranging from 0·0028 to 5–6 A./sq.dm. Beyond a certain current density the cobalt content of the alloy decreases, but is in general higher than that of the electrolyte. This decrease is correlated with the impoverishment of the katholyte in cobalt ions, on account of their preferential deposition. Dilution increases the effect, but stirring eliminates it to some extent. The composition of the initially-deposited alloys is independent of the H-ion concentration; the current efficiency increases with *p*H, and the effect of impoverishment of the electrolyte is observed at lower current densities. Acetate ions do not appear to affect the deposition. In Part II, at higher temperatures the relative tendency for cobalt and nickel to deposit is found, as expected from previous results, to be independent of H-ion concentration. The alloys deposited at very low current densities contain decreasing portions of cobalt as the temperature is raised; this proportion is, in general, less than that in the solution for depositions made at 90° C. With increasing current density the fraction of cobalt in the deposited alloy increases rapidly until a constant maximum is attained; this maximum decreases with increasing temperature. The influence of cobalt on the deposition of nickel at 50° and 90° C. is very similar to that of iron at 15° and 50° C. respectively. The theoretical basis of the results is discussed in terms of the deposition potentials and overvoltages of the metals concerned. A. J. M.

2122. Recent Contributions to the Electrochemistry of Strong Electrolytes. P. J. van Rysselberge. *Am. Electrochem. Soc., Trans.* 57. *pp.* 395–398, 1930.—Experimental data are presented which show that incomplete dissociation prevails in all solutions of strong electrolytes. In the case of divalent ions, complex formation occurs. A method of calculating the concentrations of the different ionic species present in a solution is sketched. Suggestions for the application of these new facts and ideas to electrolytic processes are presented. AUTHOR.

2123. Dissociation of Strong Electrolytes. Part III. M. B. Jacobs and C. V. King. *J. Phys. Chem.* 35. *pp.* 480–487, *Jan.,* 1931. —This paper continues a previous investigation [see Abstract 4162 (1930)] and considers complete dissociation and optical properties. It is concluded that the " additivity of optical properties " is a myth; true in some accidental cases, and approximately so in cases where previously discrepancies were either not noticeable or could be overlooked. The observations now considered in connection with other experimental evidence, undoubtedly indicate that the conductivity ratio gives values too small for the degree of ionisation; but there is accumulating evidence of the existence of some small percentage of undissociated molecules, or ion-pairs or groups, in even the best examples of highly dissociated electrolytes. It is pointed out that the inter-ionic attraction theory does not require complete ionisation, and also that at the high dilutions where there seems to be fair agreement with the Debye-Hückel equations, even the Arrhenius theory postulates nearly complete dissociation. H. H. Ho.

2124. Spectrometric Determinations of the Effect of a Neutral Salt on the Dissociation of Acetic Acid. N. V. Sigdwick and L. A. Woodward. *Roy. Soc., Proc.* 130. *pp.* 1–16, *Dec.* 2, 1930.—In extension of previous work [see Abstract 1424 (1931)] the authors have investigated colorimetrically the degree of dissociation of acetic acid in the presence of potassium bromide. Using a flicker calorimeter, the value of the dissociation constant, k, for methyl orange at 18° C. is found to be $3\cdot34 \times 10^{-4}$, which is somewhat higher than that previously found but in good agreement with the value $3\cdot23 \times 10^{-4}$ found by Guntelberg and Schiödt. The curves for water, hydrobromic acid and acetic acid, in which the values of k_a/k_c are plotted as ordinates against the square root of the salt concentration as abscissæ, are all of the same general form. For very dilute solutions all the curves approximate to the theoretical curves derived from Debye and Hückel's theory. Each curve passes through a minimum at about the same salt concentration and ultimately rises in concentrated solutions ($>$ 3N) above its initial value. The curve for methyl orange exhibits a sharp contrast. This shows considerable deviation from the theoretical curve for dilute solutions; the minimum occurs at a lower salt concentration and the value of k_a/k_c rises to much higher values at high concentrations. J. S. G. T.

2125. Activity Coefficient of a Non-Electrolyte in Aqueous Salt Solutions from Solubility Measurements. J. W. Belton. *Leeds Philosoph. and Lit. Soc., Proc.* 2. *pp.* 178–182, *Jan.*, 1931.—Results are given of measurements of the solubility of N-chloracetanilide in aqueous solutions of sodium chloride, barium chloride, and magnesium sulphate at 25° C. From these data the values of the activity coefficient are calculated. The relation $\log f =$ constant $\times \mu$ holds for each salt solution for values of μ up to 4. Small deviations from this relationship at low salt concentrations are explained by considerations based on the dielectric constant of the non-electrolyte solution. T. H. P.

2126. Diffusion of Electrolytes, Non-Electrolytes and Colloidal Electrolytes. J. W. McBain and T. H. Liu. *Am. Chem. Soc., J.* 53. *pp.* 59–74, *Jan.*, 1931.—A procedure is described for rapid determinations of diffusion, reproducible to within a few tenths of 1 %, by means of the Northrop diffusion cell with a sintered glass diaphragm. The results obtained are independent of the nature and porosity of the diaphragm and are equal to the best yielded by the laborious classical methods. The Nernst equation for electrolytes at infinite dilution and the Einstein equation for uncharged spherical particles are generalised to include all cases of diffusion, and it is shown that, for simple electrolytes, the predominant influence in diffusion is the value of the van't Hoff *i* factor. As an instance of the method of summation of the effects due to different constituents in predicting total diffusion, the data for a typical soap solution are analysed and found to agree with previous information as to their properties. The data for sugar solutions show that the viscosity contributed by the dissolved substance is not that which determines rates of diffusion. The diffusion column of one substance may, by the bombardment of its molecules, accelerate or retard or even reverse the diffusion of another substance. T. H. P.

2127. Connection Between Ionic Mobility and Diffusion Velocity in Solid Salts. C. Wagner. *Zeits. f. phys. Chem.* 11. *Abt. B.* 2–3. *pp.* 139–151, *Dec.*, 1930.—A formula is derived for the calculation of coefficients of diffusion from conductivity and transference numbers or migration velocities, for solid solutions of the type AgI + CuI or $PbCl_2 + PbBr_2$. The self-diffusion constants of the more mobile ions are obtained from the conductivity of pure solid salts with exclusively kationic or anionic conduction. It is assumed that the movements of the individual ions proceed practically independently of one another, an assumption which is supported by the approximate confirmation of the deduced formula by experimental data. A. J. M.

2128. Thermoelectric Power, Thermolysis and Ionic Mobility in Solid Salts and Mixed Crystals. H. Reinhold. *Zeits. f. phys. Chem.* 11. *Abt. B.* 4. *pp.* 321–341, *Jan.*, 1931.—The investigation of thermoelements with solid, electrolytically-conducting salts, M/MX/M, showed that, even in homogeneous solid electrolytes, the temperature gradient may give rise to thermoelectric forces, termed thermoelectric homogeneous effects. Thermodynamic analysis of thermoelectric force indicates that the thermoelectric heterogeneous effect, that is, the temperature coefficient of the potential change at the phase boundaries of the two conductors of the element, in general amounts to only a small part of the total thermoelectric force. The main part of this force arises from the homogeneous effect which, in cases where the two magnitudes have different signs, is even greater than the total thermoelectric force. Only for elements with salts of abnormally high conductivity are the three effects of about equal magnitude, so that the influence of the heterogeneous effect predominates. Ionic mobility and the Ludwig-Soret effect in mixed crystals, and ionic mobility and the thermoelectric homogeneous effect in solid salts, are also discussed. T. H. P.

2129. Conductivity Measurements and Titrations. F. L. Hahn. *Zeits. f. Elektrochem.* 36. *pp.* 989–991 *Dec.*, 1930.—Electrolytic conductivities may be conveniently and accurately measured by means of a copper-cuprous oxide-lead detector as rectifier and a galvanometer used as a null instrument. The method is especially suited to series of measurements as, for instance, in conductometric titrations. T. H. P.

2130. Measurement of Electrolytic Resistance by the Barretter Method. J. Schiele and M. Wien. *Ann. d. Physik*, 7. 5. *pp.* 624–632, *Dec.* 3, 1930.—The Kohlrausch method requires the product of electrode surface and electrolyte resistance to be not less than 30 sq. cm. ohm. A method is described in which frequencies between 10^4 and 10^5 are employed to give, with a barretter circuit, a corresponding limit of 1 sq. cm. ohm. The effect of polarisation on the resistance diminishes with increasing frequency. The effect of the applied voltage depends on the state of the electrodes; with unplatinised electrodes, the resistance diminishes with rise in voltage, but the change of resistance with voltage is almost zero when platinised electrodes are employed. G. E. A.

2131. Conductivity of Electrolytes in Nitromethane. C. P. Wright, D. M. Murray-Rust and H. Hartley. *Chem. Soc., J. pp.* 199–214, *Jan.*, 1931.—A method of preparing nitromethane suitable for conductivity work is described. Its density and viscosity at 25° C. are respectively 1·1312 and 0·00627. Addition of water lowers the viscosity, and addition of nitromethane raises the viscosity of water, although the latter is the more viscous of the two. At 25° C., the approximate solubility of water in nitromethane is 2 %, and that of nitromethane in water, 10 %. Measurements of the electrical conductivities of nitromethane solutions of certain uni-univalent salts and of perchloric acid ranging from 0·0001*N* to 0·002*N* at 25° C. show that only the tetraethylammonium salts give a linear relation between Λ_c and $\sqrt{c}$, other salts conforming to the empirical relation $\Lambda_c = \Lambda_0 - xc^{\frac{1}{3}}$. For the tetraethylammonium salts, the ionic mobilities agree well with the Debye-Hückel-Onsager equation, but all the other salts show wide divergence from ideal behaviour. The results show that ionic association is not entirely controlled by the electrical forces between the ions. Small amounts of water increase the conductivity of electrolytes in nitromethane, the increase being of the same order as that of the fluidity with the tetraethylammonium salts. Perchloric acid is a fairly strong electrolyte in nitromethane, the mobility of the hydrogen ion being 63. Other acids are very weak electrolytes in this solvent. T. H. P.

2132. Conductivity of Electrolytes in Nitrobenzene. D. M. Murray-Rust, H. J. Hadow and H. Hartley. *Chem. Soc., J. pp.* 215–219, *Jan.*, 1931.—Results are given of measurements of the electrical conductivity of four uni-univalent electrolytes in nitrobenzene at concentrations 0·0001–0·002*N* at 25° C. Tetraethylammonium picrate and perchlorate are strong electrolytes and yield results in agreement with those calculated from the Debye-Hückel-Onsager equations, but silver perchlorate is appreciably associated. Perchloric acid is an electrolyte of intermediate strength, and gives the value 43 for the mobility of the hydrogen ion, so that it is not abnormally fast in nitrobenzene as it is in hydroxylic solvents. Nitrobenzene is similar to nitromethane as an ionising solvent, but the tendency towards ionic association is rather greater in the former. T. H. P.

2133. Electrical Conductivity at High Temperatures of Solutions of Common Salt and of Concentrated Sulphuric Acid. F. J. Symon. *Roy. Techn. Coll. Glasgow, J.* 2. *pp.* 395–401, *Jan.*, 1931. This paper describes the measurement of the electrical conductivities of aqueous solutions of common salt for concentrations up to 1·13 % (800 grains per gallon), for temperatures from 10° C. to 230° C. Above 100° C. the solutions were necessarily under a pressure which rose to about 400 lb. per in.^{2} at 230° C. The conductivities of sulphuric acid of concentrations from 94 % to 99 % were also measured for the temperature range 15° C. to 50° C. Values given in the Smithsonian Tables (1920) for a few dilute solutions of common salt are suggested to be in error by about 4 % at 100° C. and 17 % at 218° C. AUTHOR.